Southern Branch
of the
University of California
Los Angeles

Form L-1

MATERIALS and supplies today are handled in such quantities that every detail is lifted into importance. The tendency to refine quality by exact chemical tests is indicated by the Pierce-Arrow laboratory, and the tendency to arrange deliveries so that material can flow into production almost without pause by the Ford method of receiving and handling small parts in standardized boxes

SHAW FACTORY MANAGEMENT SERIES

MATERIALS AND SUPPLIES

PURCHASING METHODS—STANDARDIZING YOUR MATERIALS—STORES KEEPING—STOCK RECORDS—INVENTORIES

A. W. SHAW COMPANY
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PURCHASING METHODS

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FOR PART I

Chapter I. D. R. Swinton, mechanical engineer, of the Tuthill Spring Company, H. M. Wilcox, formerly of Miller, Franklin & Company, and Mr. Porter contributed this chapter. It is based upon a study of purchasing methods in the Kohler Company, the Bureau of Docks and Yards of the United States Navy Department, a textile mill, machine shop, and other plants.

Chapter II. Contributed by Johnson Heywood, former assistant in purchasing with Stone and Webster, and Mr. Porter.

Chapter III. Contributed by Mr. Rockwell and Mr. Porter, who have drawn on the experience of Miller, Franklin & Company, efficiency engineers; Irving A. Berndt, head of the betterment department of Joseph T. Ryerson & Son, F. A. Marsh, purchasing agent, Link-Belt Company, A. B. Farquhar Company, a Brockton shoe manufactory, a New York paint company, and others.

Chapter IV. Written by Mr. Porter. The plants from which the instances cited are drawn are the Lamberson Japanning Company, A. B. Farquhar Company, Edison Storage Battery Company, a Connecticut brass company, and a printing company.

Chapter V. Contributed by Ford W. Harris, consulting engineer, formerly with the Westinghouse Electric and Manufacturing Company, and Mr. Porter. The specific lines of manufacture referred to are household utensils, hardware, umbrellas, electrical devices, engines, chains and automobiles.

Chapter VI. Contributed by George H. Cushing, of the Black Diamond Publishing Company, and Johnson Heywood, in collaboration with Mr. Porter. The chapter presents the purchasing methods of the Commonwealth Edison Company, A. B. Farquhar Company, an ore-boat line, and other concerns.

Chapter VII. Contributed by Sterling H. Bunnell, works manager, Griscom-Russell Company; Chas. W. Bane, and J. W. Wiley, assistant secretary, The Meyercord Company.

Chapter VIII. This study of purchase forms and systems is drawn from the experience of Mr. Porter; J. V. Hunter, mechanical engineer; A. J. Borget, Velie Motor Vehicle Company; N. Cannon, purchasing superintendent, Joseph & Feiss Company, and W. J. Miskella, president, Lamberson Japanning Company. Written by Mr. Porter.

I

BUYING BY THE PROFIT TEST

SOUND buying for any of the factory's needs—construction, equipment, material, supplies—means, except in a few emergencies, buying what will return the greatest permanent profit. Purchasing as well as production is only a step towards the factory's final goal of dividends. But to buy into profits demands foresight; good purchasing calls for the ability to calculate ahead and anticipate savings or advantages from investments not yet made. Before a contract is signed covering the raw material for many months ahead, the purchasing agent and those working with him must determine what material gives the most suitable product with the least outlay. To do so involves not only comparative tests of greater or less intricacy, but also difficult estimates of future direct and indirect charges.

Comparative figures were recently made on the cost of a wood constructed factory with engine drive, as against a fireproof construction, with electric drive and automatic sprinkler protection. The cost of the former, including all machinery, was $28,000, as against $38,300 for the latter. The difference in insurance premiums, however, amounted to more than two thousand dollars per year in favor of the more expensive plant.

This saving, it is seen, is almost a twenty per cent dividend upon the difference in cost. Thus, without taking into consideration numerous other economies which the higher class structure is certain to give—such as less maintenance expense, less wear and tear on equipment, reduced depreciation charges on both buildings and machinery, a higher marketable value, the attraction and holding of a better grade of help, better sanitation, less

cost to heat—the more expensive building was amply justified.

And so it is in many instances. *Capitalizing* the real economies shows the higher priced article—be it a building, a piece of equipment, a system of heating and ventilating, a paint for interior use, metal window frames and sashes and factory ribbed glass, permanent roof covering, power units, fuel, supplies, raw materials of manufacture, or what not—to be actually the cheaper, though the first cost be ten, twenty or even fifty per cent greater. "The best is the cheapest in the end" almost invariably; and a shrewd mathematical forecast will usually prove the rule.

Those manufacturers who have shown themselves most progressive do not spend their money on high-class construction, equipment and stock for the love of spending it or because their innate sense of the artistic compels them to. It is a case of matter-of-fact utility, prospects of greater actual returns on their money, pure and simple. Every manufacturer will recall how a grade of steel, of lumber, of oil, of varnish, cost more but saved double that excess when it came to actual use.

Take window construction. Manufacturers have come to realize that metal frames with ribbed glass pay, regardless of the requirements of the fire-insurance companies. These should be provided throughout, even though the purposes of fire-protection do not so require. The practice formerly was to put metal frames and sashes only where absolutely required and wooden frames and sashes elsewhere.

Regarding the actual economy of the metal frames and sashes, a manager who recently completed a new plant thus fitted throughout, commenting upon the comparatively small amount of heat required in his new factory, states:

"We attribute this result largely to the use of metal sash, properly grouted into the walls, thus making them absolutely air-tight and heat leak-proof. Our experience leads us to believe that we may safely figure the exposure of metal sash properly grouted into the wall at the same ratio as solid brick walls.

"Ordinary brick is quite porous. Window glass, on the other hand, is non-porous, so that, while it may offer greater radiating surface, the outside wind pressure cannot penetrate and the leakage is nil. At any rate, be that as it may, the fact remains

that we are heating our building with less than half the theoretical amount of radiation, based on tests made with wooden sash. It seems fair to assume, therefore, that it requires more radiation to overcome the leakage around the ordinary wooden sash than it does to take care of the glass exposure."

This manager found that, capitalizing the savings in fuel consumption for heating purposes alone, he was more than justified in using metal frames instead of wood. For every dollar saved on the coal bill he could afford to invest sixteen dollars and sixty-seven cents in permanent improvements, one dollar being the interest at six per cent on $16.67. So if he saved only one hundred dollars on his fuel, he would be justified in outlaying $1,667 more for steel windows than for wood. The numerous other advantages—more light, greater durability, less maintenance cost, better fire protection, hence decreased insurance premiums, if also capitalized, would swing the balance very heavily in favor of the more expensive article. In addition there is the saving on the investment in heating equipment and the reduced operating expenses, another clear gain in favor of the steel frames. Thus questions of construction and equipment purchasing need to be solved in connection with the larger items of materials and supplies.

REAL ECONOMIES FREQUENTLY JUSTIFY GREATER FIRST COST

SIMILAR considerations go into every decision to purchase for the factory. Take prismatic glass. Though more costly than plain glass, it is, properly set, much superior. Placing the ribs outside catches the rays of light, diffuses them and throws the light into the room without shadow. With plain glass there is no diffusion; the light passes through and strikes the floors and walls with a blinding glare. Shadows are always prevalent and the light in general is not to be compared to the soft, penetrating and shadowless light of the prism glass. Real economy again appears, based on greater first cost.

Sometimes the line of economy takes the direction of increasing equipment in proportion to the manning. This instance of an automatic grinder is typical. Both roughing grinding and

finishing grinding were being done on one machine. The method was to run a lot through the roughing process; then reset the machine and run the same lot through a second time. A time-study disclosed much lost time. So a different arrangement, based on the use of two machines, both tended by the one operator, one to work exclusively on the roughing grinding and the other on the finishing grinding, was worked out. Analysis showed that a saving of forty-four and one-half per cent in the time per piece could thereby be effected. But would this increase in the output be sufficient to bring justifiable returns on the investment in one additional machine? Also what percentage of time would the machines be idle between the time the grinding is automatically completed and the operator gets the machine started again?

It was found that it took the man 0.33 minutes to complete his round of motions from the time the machine was started until he returned to unload and load it again. The automatic part of the operation took 0.30 minutes. Thus, with two machines, 0.03 minutes would be lost on each machine on each operation of grinding. Hence the machine efficiency would be ninety-one per cent as compared with the old method.

It was assumed that there would be enough work to keep two machines busy. The cost of a machine was about two hundred and fifty dollars. It was estimated that twenty per cent would cover the yearly charge for interest, depreciation and repairs. The operation charge per machine per year figured out fifty dollars.

A twenty-cent-per-hour man was doing this work. Thus, the expense of the man per year, working full time, would be $572.00. Deducting twenty per cent from this to cover non-productive time, that is, time spent on set-ups, adjusting machines, "rest," personal needs, and so on, and taking forty-four and one-half per cent of the balance, the saving in labor by the new method figured $210.00 per year. Against this was a charge of fifty dollars for the additional machine, leaving a net saving of $160.00 per year, which is the interest on $2,667.00 at six per cent.

When the wisdom of making a purchase of new equipment, or, for that matter, any item entering into manufacturing from the "roof over the processes" on down to the ore, leather, wood,

clay and glue, or the brushes used to paint the product, is figured out in this way, when in each instance the *economies* are *capitalized,* purchasing is put on a true scientific basis. Sentiment, prejudice, favoritism, circumscribed vision, ultra-conservatism, snap-judgments, lowest first cost—in fact, all the "bogies" of unscientific buying, are automatically ruled out when the wisdom of purchases is so tested.

This is the method very generally followed by the Government. In the Bureau of Docks and Yards of the United States Navy Department, for instance, before any purchases of new machinery are made, the difference in original cost is balanced against the difference in economy guaranteed by each bidder. If in the market for steam machinery, for instance, the Bureau requires the bidders to guarantee the steam consumption of the several outfits proposed, and assuming ostensible values for the cost of fuel and rate at which it will evaporate water in the boilers, they calculate the probable saving in fuel per year. The difference in cost of fuel is taken as an *annuity* for a term of years conservatively estimated to represent the life of the machinery, and the *present worth* of this annuity is then used for comparing bids.

It is merely a matter of arithmetic to show that the payment of one dollar a year for fifteen years would be equivalent to a capital in hand of $9.71, if that capital were earning interest at six per cent, compounded annually.

Hence, it is assuredly justifiable to spend $9,710 for an outfit that will save $1,000 a year for fifteen years, capital valued as above. Almost invariably, too, the equipment designed for most economical operation would be the most smoothly running and in every way the most reliable outfit.

Similarly, small differences in the operation of an outfit, in a plant of any size, will on occasion show even greater savings in favor of one or another of the outfits tendered.

The makers are required, according to the specifications of the Bureau of Docks and Yards, to guarantee the saving claimed, and if on test the plant shows a less saving, an amount equivalent to the shortage, calculated on the basis of an annuity as explained, is withheld. This arrangement makes the bidders extremely careful not to overstate the case in favor of their own equipment.

How the government handles these matters contains suggestions for the manufacturer. He cannot perhaps apply the method in exact detail to all his purchases, but it would seem that he could adopt it with regard to competing sources of raw materials and standard equipment, which represent so large a money outlay, in view of the wide range of choice offered and the keen competition among rival suppliers.

Or, the problem may be whether to buy his power of a central station, or make it himself. Sentiment or trivial considerations should not lead him into making the wrong move. It is perfectly possible to reduce the matter to a cold business proposition. Sometimes it works out to the advantage of the central station; other times, when offhand the advantage seems to lie in that direction, capitalizing the relative economies will show the advantage to be precisely the reverse.

So, in the matter of every large purchase, and especially those materials and supplies which figure large month after month, tests and figures should decide. The manager should insist on estimates being worked up for the various competing items, and so learn their respective merits unbiased by the enthusiasm of the moment. If the calculations have been made properly, the best course to pursue in purchasing will be evident.

II

KEEPING IN TOUCH WITH THE MARKET

ONE week the purchasing agent for a Chicago factory nodded a deferential salesman his routine order for a thousand pounds of solder; the next he crowded into a market flanked with sales managers directed to discourage heavy buying, and at the earliest moment pledged various suppliers to contracts for ten tons. War had been declared in Europe.

To purchase well in and out of season calls for the foresight, enterprise and thorough knowledge of markets which enable the buyer to save his concern in no matter what crisis among prices and deliveries. The morning newspaper needs to speak to the purchasing agent in terms of his supply sources throughout the world. His insurance against high prices, poor quality and shortage is always to keep the entire field of sources available.

Thus to study the strategy of your markets merely requires energy and method. It is easy to obtain a list of concerns handling any particular product in any given territory. In the course of several years' experience with them, a buyer can eliminate the unreliable concerns and get a good line on the ability of each to make deliveries. This is slow work, however, and not so conclusive as other and quicker methods.

Surprisingly often a purchasing agent will overlook a concern literally "under his nose," which is able to make quick deliveries from stock on material which he has always bought from a distant source, thereby inviting costly delays. Frequently, too, you can find manufacturing plants that are able to turn out products which they do not attempt to push as their standard lines.

There is a wonderful chance at present for further cooperation

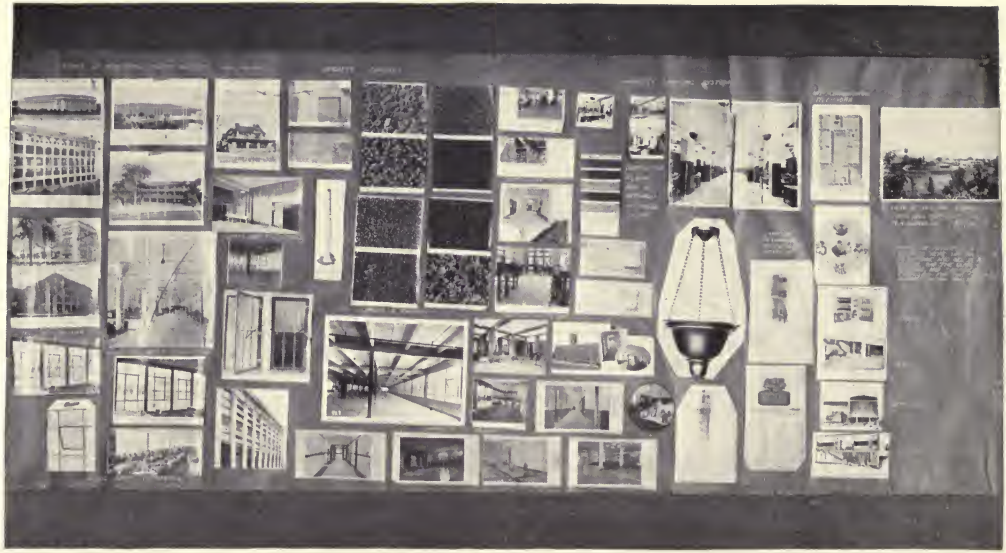
in America along this line, between factories which might give service to nearby enterprises and purchasers who might develop sources close at home.

Recently a buyer was in the market for a large quantity of an assembled product consisting of drop forgings, bolts, pins, and so on, all to be galvanized, and each assembly to contain about forty pieces. Inquiries were sent to all recognized manufacturers in this line, but only two bids were received and these varied widely. As a last resort, the inquiry was sent to a machine shop in a neighboring city, which had no facilities for galvanizing. This shop some time before had turned out several thousand special bolts on which the workmanship and delivery had been excellent. When its bid on the new assembly proved slightly lower than those received from the other bidders, therefore, it was decided to award this shop the contract.

The owners agreed to install a galvanizing tank inside of a month and asked that the purchaser provide an inspector in their plant to pass upon the parts in process and the finished product. This was done and where the inspector found shop conditions which could be changed to the end of obtaining better or quicker work, his suggestions were gladly accepted. The contract was delivered strictly according to schedule, the workmanship was all that could be asked and what was more, the manufacturer made a satisfactory profit. By careful investigation, the purchasing agent often finds such small shops which are in a good position to turn out special work beyond their line.

Not infrequently, too, he will find some small shop with a resourceful manager who will undertake exceptional jobs in his line with which the big fellows will not bother. A large steel mill in the Chicago district was about to refuse a large order for long Tee-irons, furnished with one coat of japan baked on, because it had not the facilities for this kind of work and could not, moreover, locate an enameling shop which was willing even to bid on the job. As a last resort, the purchasing agent called up the head of a small japanning works, only a short time in the field, but which already had come to his favorable attention. "Yes, we will be glad to bid on this order," was the response, after a few moments of calculation. "I shall have it ready for you tomorrow."

Nothing gains the cooperation of salesmen like a reputation for discretion on the part of the purchasing agent. The office shown below illustrates how the purchasing agent keeps other affairs out of the way when the salesman calls. The office at the top (Baker-Vawter Company) is equipped with filing room in which the buyer's records are always at hand, but confidential quotations are given privacy



One of the purchasing agent's problems is how to give due consideration to all items or sources of supplies or special purchases that deserve it. To get a perspective upon the whole problem and to have a reminder of all the materials and devices which the management wished to consider in the erection of a new building, the Baker-Vawter Company posted clippings upon the office wall for final decision by the board of directors

True to his word, the manager of the japanning company sent in his bid the next day and the purchasing agent was agreeably surprised at the reasonableness of the figure. He had felt, owing to the lack of competition, that he would be held up for a fancy price. He was in some doubt, however, of his bidder's ability to make good. When the latter explained his method for handling the order, doubt gave way to admiration. The japanning man's scheme was this: Realizing the impossibility of handling such a job economically in the city, he planned to put up a cheap structure in the country, handy to a switch, where he would have plenty of room to store the Tee-irons and have no cartage to pay. Then, instead of building an ordinary oven, he proposed to construct one on the hood principle, which could be lowered over a pile of irons. The steam coils he would place in a pit beneath. Another pit nearby would serve for dipping purposes. The operation then would resolve itself into dipping the pieces several at a time, stacking them up on an open platform truck and wheeling the truck to a point over the steam coils, then lowering the hood and turning on the steam. By the time the one charge was baked, another would be ready. He had his costs figured out in detail and although he had added a liberal margin for contingencies and profit, his price, owing to the exceptional economy of his method of handling the work, was remarkably low.

This may be the only job he will do at the special plant. But the order is large enough so that its cost will be completely absorbed. The chances are, however, that having the facilities he will get many more such jobs, from this and other buyers, for which he will have his plant free of investment charges. Thus it is that persistent and broad-gaged purchasing agents fortify themselves for special requirements, by searching out small shops which can be developed into permanent sources of supply.

A purchasing agent thoroughly experienced in buying factory supplies on the Pacific coast recently took the same position with a construction company in the Middle West. His ignorance of many of the tools and materials and his unfamiliarity with the markets staggered him. Before buying for the job must begin, he had a margin of only thirty days in which to learn his markets.

Campaign plans full of suggestions for any purchasing agent were at once launched.

His first step was to secure an authentic buyer's directory, the telephone directories of all large nearby cities and to subscribe to several trade papers, the leaders in the fields of electricity, lumber, iron and steel, railway, hardware and building. Then, with the help of the superintendent of construction, a comprehensive list of materials that would probably be used was drawn up. With this list and the buyer's guide, trade papers and telephone directories to furnish the names, letters were written advising of the work under way and asking for catalogs. This brought a flood of sales literature, all of which was carefully examined by the purchasing agent personally.

HOW ONE PURCHASING AGENT ORGANIZED HIS SALES LITERATURE

So many jobber catalogs were found to be identical, that all but the most comprehensive in each line were destroyed to save space. Those covering similar lines of material were grouped, indexed according to the firm name and cross-indexed according to class of material. A list of jobbers and manufacturers was also made up, classified according to materials handled or produced. This was known as the inquiry list and as time went on other names were added. As experience showed that a concern was unreliable or undesirable, its name was dropped.

A small army of salesmen and sales managers responded to the first letters sent out, in addition to the catalogs. Every one who called was given a courteous hearing and the buyer endeavored to get on a personal basis with them all. He realized that as a purchasing agent he would hear only the salesman's talk about his line and the firm, but as "Bill Jones" he would get "Tom Robinson's" real feelings and intimate knowledge of his particular line. So the human side was developed and each salesman encouraged to talk.

Next a trip was taken to neighboring jobbing centers, after appointments had been made with the leading houses in the lines in which he was interested. These visits were made primarily to see what classes of materials were actually stocked and how large the stocks were, and secondarily, to become acquainted

with the heads of the firms. It is always best to talk to a man high in authority when bad deliveries or a break-down calls for the use of the long distance telephone.

The knowledge the buyer gained of the actual stocks carried by jobbers was of great value in placing orders when a small quantity of material was needed in a hurry. He also visited various manufacturing plants for the purpose of noting the exact kinds of work which they were prepared to do, the character of the equipment and the apparent ability to handle large contracts expeditiously. Copious notes were made of conditions as revealed on these trips and formed part of the buyer's confidential information book. Thus a good general knowledge of supply sources was obtained. To determine the most satisfactory houses with which to deal, it only remained to compare prices and qualities, which was done when the actual buying began.

Upon going into the market for lumber, the wide difference in trade customs in different sections of the country was forcibly

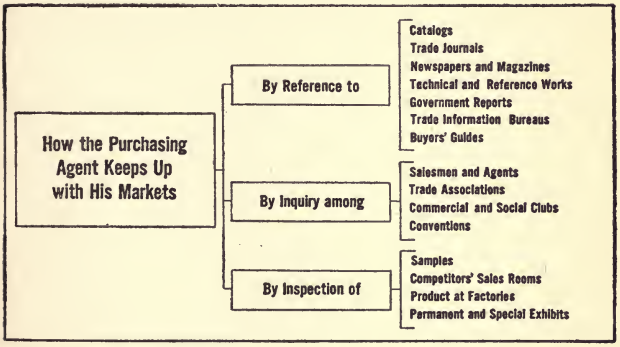


FIGURE I: Three methods by which the buyer keeps in touch with constantly changing markets are here charted. Highest efficiency in his office necessitates an accurate and a flexible system under which he can file for instant reference the information gleaned from catalogs and trade journals. The value of such a system is greater if it contains records of inquiries among salesmen, agents and other sources, as well as reports of all inspections made by the buyer

brought to this buyer's attention. His experience had been in the northwest, where white pine and fir were the standards. The rail haul from mill to consumer had been very short and the price of rough lumber had therefore been less than that of

finished. In his new location, yellow pine was the only available wood, and there was a long rail haul from the southern mills. It astonished him to find that finished material was several dollars cheaper than rough because the decreased weight made the freight per thousand feet much less. The grades and qualities were also entirely different from those to which he had been accustomed.

His first order would require several million feet, all of which would have to be delivered within ninety days. It appeared impossible for him to get any accurate information in the short time available as to the southern lumber manufacturers. St. Louis, one of the largest yellow-pine markets, was within easy distance of the point of delivery, however, so he made a trip to that point, and submitted specifications to a half dozen brokers or mill representatives and also to four or five large lumber dealers who carried heavy stocks in their yards. Prices for mill shipments from both classes of bidders were about on a par, so the order was split to give several mills each a part of it. This not only prevented one mill from being swamped, but also insured the purchaser against the chance of accident, flood or strike tying up his shipments.

In addition, all the orders were placed through concerns which carried stocks in St. Louis. This was a wise precaution, for the purchasing agent saw that he would need at various times carload lots of lumber on such short notice that they would have to be supplied from stock. His judgment was correct and when his urgent need came, he found the yards in a grateful frame of mind, ready to do everything possible to get his requirements to him in record time; and, what was equally to the point, not to take advantage in the matter of price.

PROFITABLE BUYING DEMANDS CLOSE OBSERVATION OF CONSTANTLY CHANGING MARKETS

IN getting at the "where" of the markets, class journals and trade papers are of great value; they put a buyer in direct touch with the manufacturer. Most manufacturers of high-grade products realize the benefit of direct contact with the consumer and know that the surest way to do this is to advertise in the proper class and trade organs. Every wide-awake purchasing

agent is habitually a reader of the advertisements and market reports given by these papers, having thus a perspective on price movements from the viewpoint of the industry as well as through the general and special quotations of the individual concerns with which he has listed his wants. It is almost a rule, indeed, that the amount of large buying a man does through a jobber is a sure index of how lazy he is. This applies to large plants only and is not to be construed to mean that the jobbers can be or should be eliminated. On the contrary, the jobber has very real functions to perform. The three greatest ones are to supply stock for quick delivery, to furnish small assortments and to handle the business of the smaller concerns whose individual orders a manufacturer could not handle profitably, but which, in the aggregate, are large.

To learn all the trade customs in various lines, there is no short cut. Careful study of catalogs, the willingness to see and learn from all salesmen, and when possible, the personal examination of material for the sake of familiarizing yourself with it, are all essential. Some purchasing agents do not seem to realize the value of familiarity with the details of trade customs and by that failure, fall in the estimation of the salesman. The latter, when he realizes that a purchasing agent has accurate knowledge of a line, is put on his mettle and freed from any temptation to take unfair advantage (Figure I).

There are, of course, a multitude of customs which must be learned if one wishes to purchase rapidly and well—many of them apparently arbitrary. Why, for instance, should rubber insulated wire be sold by the foot, while weather-proof wire is priced by the pound? A pound is the unit for steel or iron wire, but a foot is the measure for wire rope, which, by the way, is one of the few standard steel products that is not governed by the pound price. The movement among manufacturers to standardize list prices of many items such as valves, pipe fittings and tools is making the work of the buyer easier. Only a small part of the field has been covered, however, and until this work is completed, the successful purchasing agent must not only be a keen business man, but in addition a mental encyclopedia covering many trades.

III

SUPPLYING THE FACTORY'S ROUTINE NEEDS

DOES the shop receive exactly what it wants without delay and without the creation of a burden of carrying charges, depreciation and obsolescence on an unnecessarily large lot of supplies and materials? This is the chief problem in supplying the everyday needs of the factory. The elimination of items and qualities that prove expensive, of high prices, of express transportation rates, and of telegraphic orders for rush deliveries due to "shortages" are its factors. The solution lies in knowing your sources, your specifications and requirements and the conditions in the shop.

Experience tables of past quotations, prices paid, service and quality are to be built up as the first requisite. They enable the buyer to tag unreliable concerns and inferior material. Moreover, this information carefully tabulated and filed is invaluable, if the purchasing agent is changed. Standardization of his experience means that his successor can steer out around his once-paid-for mistakes.

To buy when the market is naturally low is basic. This point may to advantage be visualized graphically. In the office of a New York buyer, for example, the market prices of all the products in continuous demand by the factory are charted for the preceding ten years. A glance at the chart shows that the price of this material is, as a rule, lowest in August, of that in November, and so on. Close study of market conditions and the bringing of the chart down to date weekly have given this purchasing agent an unusual insight into price trends (Figure II).

On the other hand is the trend of demand. The purchasing

agent must have his similar mechanism for foreseeing the wants of the organization itself. He needs to be intimately familiar with and even actually a part of the operating system. Knowledge of peculiar needs in both product and equipment will scarcely be gained in any other way (Figure III).

To know the why and wherefore behind the specification means more intelligent buying. Every purchasing agent bargains on the basis of specifications and, in the course of supplying stock needs, these become standardized. Quality once attained is permanently assured. The buyer's knowledge of what raw materials are to be had, with qualities and costs and how suppliers stand on deliveries and so on, needs to be capitalized and included in the specification.

Opportunities for large economies in standardization also await the live purchasing agent. A buyer of this sort in a New England machine-builder's plant, within a month after replacing an "old style" purchasing agent who spent most of his energies in dickering over prices, more than earned his salary by having the bolts and screws in the product fixed at a standard size and gage. Similarly a purchaser in a large factory in the Middle West standardized the oil. Previously, seven different kinds of oil were used in the various departments, due to the prejudices of the men. By the use of an oil-testing machine, he found the one best oil. The resultant saving netted several thousand dollars annually.

In another instance, some forty-odd different kinds of files were reduced to seven, without in any wise inconveniencing the shop. A much smaller stock in aggregate was thus made possible, with a decrease in investment and in storage space required. Because, too, a larger quantity of each style and size of file could be carried, the purchasing agent obtained better prices. The saving was thus two-fold.

It is necessary to be on the watch constantly for new ideas, new materials or supplies which may increase production, lower costs, or enhance quality, says H. A. Russell, of the buying staff of the A. B. Farquhar Company. In order to make sure of the result, however, most new things must first be given a thorough tryout in the factory. Verbal reports seldom are sufficient and may lead to disputes later on. Accordingly, a definite

form has been devised (Form XXIII) for getting a report from the foreman in whose department the material will be used. When the salesman calls again, if the report meanwhile has been returned, it is shown to him. This indicates where the material is falling short, if at all, and why. Whether he will be given an order depends on a sample which will receive a favorable report.

Every progressive buyer, in fact, today takes the "show me" attitude with respect to the things he pays out the company's money for—materials, supplies, services, tools, construction. He insists upon what he has found to be the fit standard of quality

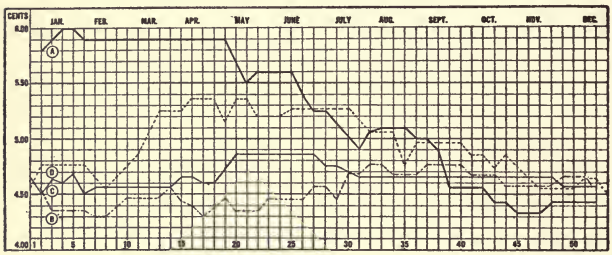


FIGURE II: New York wholesale prices in cents and fractions per pound on granulated sugar are here shown graphically by weeks for four years, (A), (B), (C), (D). Such figures may be gleaned from government bulletins, newspapers and trade magazines. In handling these figures, prices were used for the fifty-two or fifty-three successive Thursdays of each year

or performance and sees that he gets it by testing. He buys nothing on chance or somebody's say-so or out of friendship. For he realizes that standardized conditions, low and stable costs and uniform quality of output are impossible unless the materials and instruments of production are likewise standard.

TESTING RAW MATERIALS IN THE LABORATORY KEEPS A CHECK AND BALANCE ON PRODUCTION

SO the large manufacturer equips his plant with laboratories—physical and chemical—wherein such tests as are necessary may be made with every facility. And he does not leave their location and arrangement to after-thought, but provides for them in his original plans, in order that they may function to the best possible advantage.

Nor does he stop at providing for routine testing, but equips his laboratories to reach out into the future and develop new and better methods and processes, materials and equipment. Every

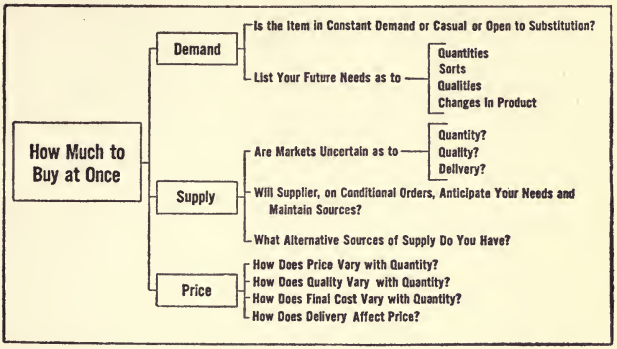


FIGURE III: Demand, supply and price must be taken into consideration in deciding how much to buy at once. The questions listed under each head suggest the factors that enter into the problem. Right buying is based on definite knowledge of the conditions suggested in the chart

big item on the purchase ledger is constantly under the microscope which searches for more value and lower cost. If the plant is small and a private laboratory is not feasible, close connections are established with commercial laboratories whose services can be secured for a small fee. Many times, however, such tests as can be devised in the workrooms of the factory, out of the experience of the men, answer every purpose.

These methods have a double value. As a part of his inspection system, testing his raw materials provides the manufacturer with the necessary check and balance on production to hold it up to standard. As a factor in creating demand and holding trade, it is primary and fundamental; nothing is so potent in this respect as a standard of quality. One does not buy a certain favorite brand of soap solely because advertising has made its name unusually known, but also because in quality it is satisfactory and uniformly good.

A careful buyer also watches the other end—the consumption and output of the factory. These he gages by keeping tab on

equipment, plant capacity and sales. If there is a breakdown of machinery or interruption to production, the consumption of course is decreased. Sometimes, this allows an opportunity for advantageous delay in placing or pushing a contract.

Moreover, definite and vital relations exist between the purchasing and sales departments, though frequently they are not recognized. The purchasing agent buys when the market is low and often several months in advance of the needs of the factory in order not only to get the best price but also to give the supplier

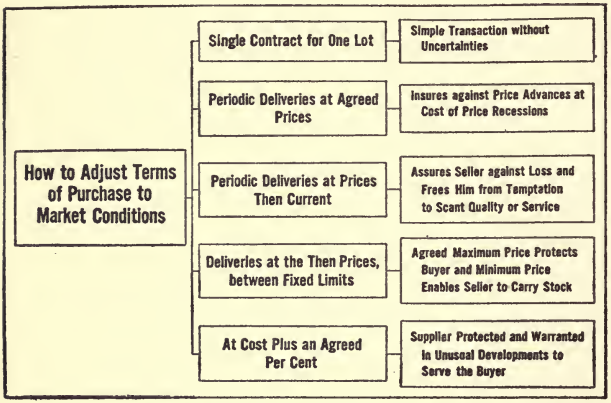


FIGURE IV: Five methods of adjusting terms of purchase to market conditions are here shown. Each method has one or more distinct advantages, as indicated at the right. The choice should reflect the best possible adjustment between the demands of the business and conditions in the market

time to fulfill his contracts. One adding-machine manufacturer, for instance, carries a two and even a three years' supply of his special steel as a protection against some unforeseen interruption in the supply, as a strike or lockout might bring about. To provide intelligently for such basic needs of the factory, an estimate of the volume of sales for the coming year is necessary. The sales manager of one plant makes out this statement in detail at the beginning of every fiscal year. It covers the probable sales for each commodity turned out by the plant. But the estimate is not sent to the purchasing agent until it is examined and ap-

Purchase Department Stock and Order Record November 1st 1913

MATERIAL REQUIRED FOR 100 - 9 X 8 Grain Drills - Domestic #1

No. Pieces one Machine	Pattern No.	SIZE OR DESCRIPTION	Material and Grade	Total Number Pieces Required	Quantity on Hand	Required to Complete	Weight 1 Piece	Ordered	Ordered
1		Frame Angle 3"x2"x¼"x14½"	Soft Steel	100	22	78	54#	S. S. Co. #14768 11/5/13	
1		Axle 1½" □ x7'6¼"	C. R. Steel	100	25	75	41#	P. S. Co. #14769 11/5/13	
1		Hoist Shaft 1⅛" □ x6'5"	Soft Steel	100	14	86	14#	S. S. Co. #14770 11/5/13	
1		Tongue Iron 1"x3/8"x6"	" "	100	2	98	.64#	S. S. Co. #14770 11/5/13	
9		Plow Bolts ¼"x1¼" Sq. Csk		900	210	690		A. B. Co. #14771 11/5/13	
1	X2	End Hanger	Mal. City	100	9	91		S. W. S. Co. #14772 11/5/13	
9	X471	Cup	" "	900	185	715			
1	X109	Indicator	" "	100	0	100			
2	X17	Trip Handle	Pressed Steel	200	140	60		Y. O. S. Co. #14773 11/5/13	

MATERIAL — PURCHASE RECORD

Drill - Grain 9 Tube 8" Spring Hoe #1

Pieces Required	Pat. No.	SIZE OR DESCRIPTION	Material and Grade	Weight 1 Piece	Weight 100 Set	
1		Frame Angle 3"x2"x¼"x14½"	Soft Steel	54#	5400#	Low Plain & Fertilizer
1		" " " x3/16"x14½"	" "	67#	6700#	Export " "
1		Axle 1½" □ x7'6¼"	Cold Rolled Steel	41#	4100#	Dom. & Export " "
1		Hoist Shaft 1⅛" □ x6'5"	Soft Steel	14#	1400#	" " " "
1		Tongue Iron 1"x3/8"x6"	" "	64#	64#	" " " "
9		Plow Bolts ¼"x1¼" Sq Csk				" " Fertz Only
1	X2	End Hanger	Mal. City			
9	X471	Cup	" "			
1	X109	Indicator	Mal. City			
2	X17	Trip Handle	Pressed Steel			
9		Wrag Bars 1⅛"x5/16"x3"	Hard Steel Carbon 40-50	3.65#	3785#	

FORMS I and II: A good check against the overstocking of materials is afforded by this stock and order record sheet. A list of all machine parts is analyzed by the purchasing department and all items that must be bought from outside sources are noted on the material-purchase record

proved by the president. This serves as a healthy check on the estimate of the sales manager. Long-time purchasing contracts are then made with the statement as a basis. If the product is one that was manufactured in identical form the previous year, the buyer's task is simple, provided he has kept the proper records. Changed or new models, however, will require first a

new list of parts from the engineering department, together with the proper drawings. It then becomes the duty of the purchasing department to analyze these lists and ascertain which parts must be purchased outside. At the A. B. Farquhar Company such outside material is entered on 5x8 cards (Form II) and filed in a standard card-index drawer file. Every essential fact is set down, so that from the cards material can be ordered for machines in any quantity. This information is brought into active use by copying it on the Stock and Order Record shown as Form I, which is an 8½x11 sheet punched for a standard binder. While on the cards only the material for one unit is listed, on Form I the total quantities that will be required are stated. All columns except the one headed "Quantity on Hand" are filled in by the purchasing department. For this the information is furnished by the production department. The last two columns headed "Ordered" are for the initials of the firms from whom the material is purchased. A second column is provided in case all of the material wanted is not ordered at the same time. This record (Form I) affords a splendid check against the overstocking of materials. While it is still possible to have a surplus of completed machines, the parts will be evenly balanced.

Such parts as are regularly kept in stock are, of course, not entered on either of these forms, but are controlled by maximum and minimum stock limits. Daily the stockkeeper renders a report of items that have reached their low limit, stating also the desirable ordering quantity. This is really a requisition on the purchasing department to buy. If, however, owing to a decline in the demand or the prospect of a lower market or any other reason, the stated quantity seems inadvisable, the purchasing department may raise or lower it, as the situation warrants, so notifying the stockkeeper. They may also, in their discretion, alter the stock limits. In this way, the evils of overbuying and underbuying of standard materials are largely avoided.

While the value of proper purchasing data can scarcely be over-emphasized, the purchasing agent who, because of reliance on them, lost his practical grasp on the factory situation and its sources of supply, would soon fail. Records after all are only an aid. To view them in their proper light requires the constant stimulus of contact with practice.

"I spend half the time away from my desk," says C. F. Marsh, purchasing agent for the Link-Belt Company. "I am educating the trade to call in the morning; the rest of the day I spend in the shop and outside familiarizing myself with market conditions. I know the requirements of the shop and in supplying its routine needs I do not wait to be requisitioned. When the market is low I ask for specifications, and buy supplies and materials in current demand for a long period."

This is the keynote of large quantity purchasing to supply routine needs: Buy when the market is right on contracts covering a considerable period, with frequent, perhaps monthly, shipping directions (Figure IV).

Contracts may be in several forms: as straight contracts for a long period, sliding scale contracts, contracts varying with the market price of the raw materials composing the product in demand, or contracts let on a "cost plus" basis. The supplier may refuse to make a straight contract or it may not be to the

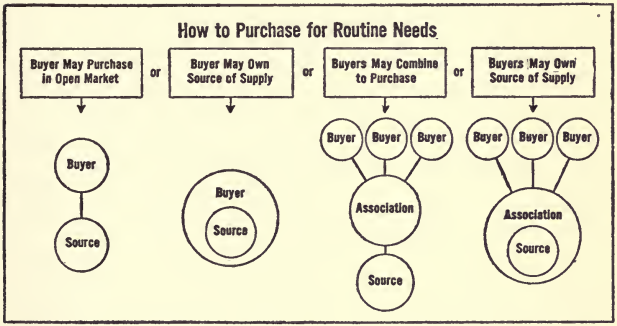


FIGURE V: In purchasing for routine needs, the common method has been for the buyer to go directly to the source through the open market or to own the source. The tendency toward cooperative buying is evident in the increasing number of buyers' associations dealing with or owning the source of supply

advantage of the buyer to tie himself down to an agreement. The buyer may then resort to the sliding scale contract, by the terms of which the price rises automatically at fixed intervals. A Chicago firm has repeatedly purchased materials at a very satisfactory price under such a contract. Three months later,

an increase of nine per cent in the original price was provided for. The purchasing agent, however, stocked up during the first three months at the lower price to meet the estimated needs of the plant during the balance of the year. But this action was not taken until the purchasing agent had calculated the real economy—that the interest on capital so invested, with depreciation and storage, were less than the increase in price.

FITTING THE TERMS OF THE CONTRACT TO THE MARKET CONDITIONS

SOMETIMES the contract provides that the prices of the supplies and material will vary with those of the materials of which the commodity to be bought is made. Such contracts may have maximum and minimum clauses which provide that the price cannot fall or rise beyond a specified point. These agreements are frequent when the market is unstable and it is often expedient to make them at such a time. If the tendency of prices is upward a straight contract for a considerable period can only be made at greatly enhanced prices, which future conditions may prove unwarranted.

Again, orders may be placed on a "cost plus" basis—costs plus reasonable profit. This is often desirable if there is entire frankness between buyer and supplier.

The contracts involving large amounts ordinarily are approved by the president. Sometimes the final approval is left to the directorate. There are, however, certain routine needs, to supply which only purchases in small quantities are necessary. In these instances, the final approval is generally given by the shop superintendent. The practice varies with particular conditions, but the point to remember is that there should be a recognized system of approval for all contracts—with the delegation of the authority to approve based on the importance of the contract.

The requirements of a purchasing department may, therefore, be summarized as knowledge of:

(1) Consumption.
(2) Specifications.
(3) Markets.

And these requirements are most satisfactorily met when it is clearly recognized that the purchasing department is an integral

part of the factory mechanism, and that it is most efficient when in close sympathy with other departments.

To supply the routine needs of his factory, the manufacturer may adopt other methods than individual direct purchasing (Figure V). Sometimes he will join with others to buy supplies and materials or to develop a supply source. The New York manufacturing bakers, for instance, combined at one time to purchase flour. Such action is seldom taken by factories in general, because the first two requirements of purchasing—knowledge of consumption and knowledge of specifications—are necessarily different for practically every plant. Moreover, the limit of price reduction by the increase of quantity purchased is soon reached. The purchaser of five carloads of coal will probably be quoted nearly, if not quite as low a price as the purchaser of fifty carloads. Still in buying many supplies and materials, there is an advantage in quantity purchasing which manufacturers may be able to capitalize to a greater extent in the future than in the past through the cooperative spirit developed by manufacturers' associations. The possibilities along this line are shown by the cooperation of certain paper manufacturers to make their own pulp from nearby timber supplies.

However, the manufacturer may deem it expedient to develop a proprietary source of supply. Sometimes the chief motive for this move is the desire to cut costs directly. A Brockton shoe manufacturer, for example, to minimize the outlay for packing lumber purchased several small tracts of timber in northern New England. The firm itself cuts the timber and ships the lumber to Brockton. At other times, however, the immediate cause for developing an independent source of supply may not be primarily the desire to reduce costs directly but rather to have alternative sources of supply. Such was the case of a New York concern which imported hard paints from Germany. To protect itself against the inability to get foreign supplies the company experimented, and found a formula satisfactory except as to price. The German manufacturer could still supply the paints at a slightly lower cost, but the American firm held the whip-hand. "If you raise the price," they said, "we'll make the paints ourselves."

IV

SPECIAL PURCHASES

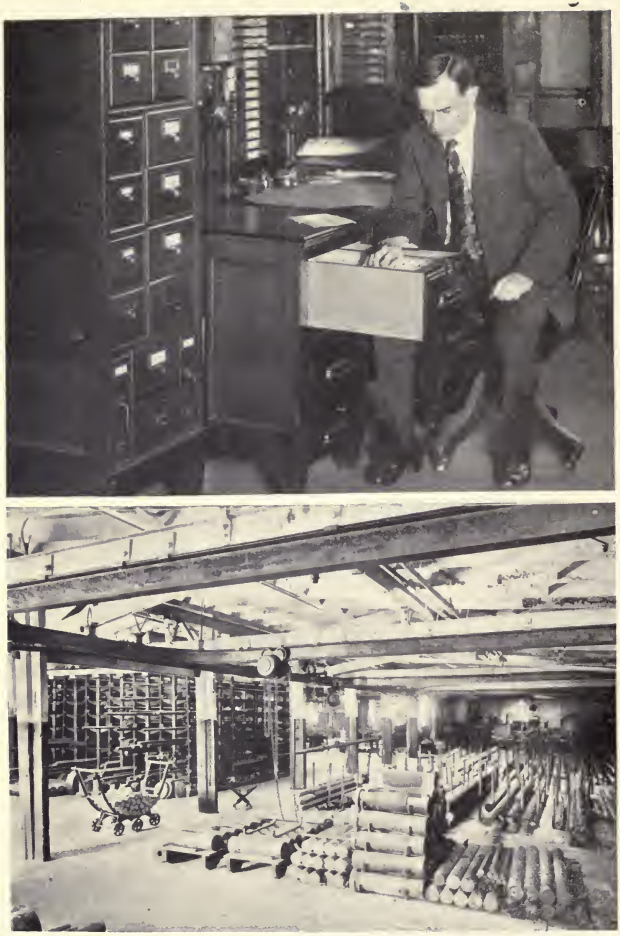
HAVING completed a new administration building of reinforced concrete throughout, a Michigan manufacturer recently faced the necessity of making a one-time purchase of material entirely out of his experience. An unforeseen difficulty had developed. As the concrete, without excessive grinding, would not afford a smooth ceiling, it had been decided to apply a thin coat of plaster. Now smooth concrete, particularly on an overhead surface, is difficult to plaster; and although an adhesive bonding coat was first applied, when the heating system was turned out, the plaster had persisted in peeling despite attempts at repairs.

This condition finally had become so annoying that the manager had the entire plaster coat removed. Then he began to look around for some coating which would not drop off and yet present a proper appearance.

He got in touch with the engineer who had designed the building (and against whose judgment the plastering had been applied). "Can you find us a paint which will overcome our difficulties?" he wrote. The designer, at the time he had drawn his specifications, had not known of a paint which just filled the bill and had counted upon the ceiling coming from the forms smooth enough, with a little grinding, to take ordinary concrete paints. However, he had quietly investigated the subject further and after fruitless conferences with several specialists, had found finally, through a salesman's suggestion, a firm which had developed a paint adapted to just such conditions.

Manager and engineer immediately consulted the representa-

Standardized purchases permit storage and delivery methods which cut costs and facilitate production. In the Eastman Kodak plant paper stock is stored on standard, numbered steel racks. Every section is served by a monorail equipment which transfers the rolls in slings to a special type of truck. This operates on an industrial railway connecting with the production department



At the A. B. Farquhar Company, desk drawer card records (top) of past prices and discounts facilitate comparison with new quotations received by telegram. In one stores department (below) good housekeeping is maintained by piling long bars between uprights set in the concrete floor, and by stacking short bars on U-shaped irons. Monorail hoists with tongs and trucks provide quick service

tive of the paint concern, who, to reassure them as to the value of the paint, agreed at his firm's expense to finish a small section of the ceiling with the new product. On the strength of this trial the purchase was shortly consummated with satisfactory results.

Ordinary purchasing records were in this case of no avail. The material wanted was decidedly special. Orders or inquiries had never gone out of the house for anything of the same nature. The fund of records and personal experience by means of which the purchasing agent continually revised and refined his every-day purchases, was totally lacking. The solution of the problem was simple, however. The manager had recourse to an outside specialist who, if not familiar with the class of material wanted, at any rate knew how new sources of supply are located. And once the source was found, by putting the burden of proof on the salesman and taking time for a demonstration, he purchased with practically no chance of disappointment as to quality.

This is a problem out of the routine, such as every manufacturer has at times to solve. From oversight, unlooked-for trade opportunities or some grave emergency, needs arise, it may be for new buildings, fittings, machinery, materials or supplies, which are decidedly novel. Often not even the source of supply is known; standards are lacking by which to judge quality, and ideas as to the proper price are decidedly hazy. If the need is not immediate, however, the purchasing department has time to investigate, supplement its scant stock of information by methods already indicated and, as in the instance given, arrive at perhaps as sound a purchase as if the item were routine.

When plenty of latitude for choice exists, the buyer who, in making a special purchase, will admit to himself his lack of experience and his need for it, has still a better opportunity to follow correct buying principles. Comparison is always illuminating.

A large manufacturer of cotton-seed oil products in the South found that the acid fumes given off in manufacture had disintegrated his roofing. He determined to find a roofing if possible which would resist the fumes. So he had his purchasing man send for samples of different widely advertised brands. From these he had his chemist cut uniform strips and place them for a

time in the neck of an exhaust hood over a retort in the laboratory which produced acid fumes. When taken down all but one showed unmistakable signs of disintegration. The one that came through comparatively unscathed accordingly was purchased with assurance.

In both of these instances service proved by test was the abiding criterion. Price was secondary and date of delivery relatively unimportant. Many times, however, one or both of the latter factors are equally important. Then the problem is more difficult.

HOW TO PLACE ORDERS IN AN UNKNOWN AND LIMITED MARKET

IF SEVERAL good sources of supply are known or can readily be found, competition will take care of prices and, to a certain extent, grade of service. If only one reliable source is developed, or time is lacking to search for more, getting a proper price may be a delicate matter.

"Under such circumstances," says one buyer, "I never let any man know that I am a novice in buying that particular thing or think he is my only source. I act as if it were an everyday matter with me. I tell him I am in the market for so-and-so and want his best price and earliest date of delivery. He knows of the competition, if I don't, and usually responds with a reasonable quotation."

Few men, however, are so constituted that they can handle the unprecedented offhand without a slip. Often, too, that the buyer is in a tight box is public knowledge. Under such circumstances, says the head of a specialty business which frequently has novel purchases to make, "I try to recall who in my circle of acquaintances uses what I need. Then I find out where they get it and what they usually pay. Salesmen friends are also funds of information on such points. By persistence and liberal use of the telephone, I usually am able in the course of an hour or so to get on solid ground as to price, deliveries, grades, sources, or whatever the sticking point is."

Instead of trying to get competitive quotations, however, it may at times be wise to buy without parley of the firm you know by reputation to be most dependable as to price and service. The

intensity of your need must determine whether test, reputation or chance is to be entrusted with the order.

A good buyers' directory is another source of help. Published lists, however, will be disappointing unless the buyer knows which firm names mean quick service. More dependable is a carefully built card list of suppliers about whom the purchasing agent has definite knowledge.

Familiarity with the stocks of suppliers, too, is valuable, according to H. A. Russell of the A. B. Farquhar Company. A buyer who knows his possible requirements, no matter how varied they may be, will index mentally a large number of items as he passes through a supplier's mill. For this reason, if no other, he should take time, whenever possible, to inspect stocks. This pleases the supplier and helps the buyer himself to an extent which can only be appreciated when a demand comes for materials to satisfy a rush order or something out of the line of previous purchases.

Mr. Russell also lays emphasis on cooperation between the purchasing, production and sales departments in the matter of anticipating unusual requirements. The sales department may have information regarding the probable receipt of an unusual order, or one which perhaps will require a larger quantity of certain items than the regular stock can supply. If this information is at once passed along to the production and purchasing departments, they can note the special requirements and begin their preliminary work. Quotations can be secured, deliveries ascertained, and a compromise, if unavoidable, struck between what is wanted and what is immediately available. When the customer's order actually is entered, the department is ready for immediate action.

This buyer's way of qualifying himself to handle special purchases is typical of the methods followed by alert purchasing men. The buyer who allows himself to be caught napping because it has never occurred to him that extraordinary needs would arise, probably lacks constructive imagination. He should picture in his own mind the operation of the plant for weeks ahead. The factory that would make the most of its opportunities cannot afford for a single day, sometimes not even for an hour, to be held back for lack of materials, supplies, equipment

and tools proper in respect to grade, entirely adequate in quantity and reasonable in cost.

WINNING WORKMEN'S APPROVAL OF NEW SUPPLIES OR EQUIPMENT

IN MAKING special purchases another point to bear in mind is the attitude of the shop, if it is an article the men are to use. Workmen and foremen alike are naturally prejudiced against new things and many an improved type of equipment or supply has found its way promptly to the scrap pile because the men felt it was being forced on them or that they should have been consulted in advance. The shop, moreover, is a valuable source of help; if properly approached the men often will be found to know when you don't.

One manufacturer has his foremen, on their vacations, "nose around" to find out about special items for which there is likely to be need. In the investigation their enthusiasm is won for the change. A Des Moines printer follows this practice himself in regard to new equipment and paper stock. At vacation time either he or his partner visits the plant of some maker whose product they are interested in. Then he visits a number of users, talks with the pressmen if possible, and thus corrects with practice what he has heard and seen in the plant of the maker.

More extensive still is the plan followed by another Iowa manufacturer. He, too, uses his vacation nearly every year to visit other shops. His interest is two-fold: to check upon advances in manufacturing methods and to observe the performance of equipment and other items he may some time need. When later he gets in touch with a supplier direct, he is already fortified by a knowledge of practice and is less likely to be swayed by salient advertising claims. This manufacturer incidentally, in the course of his many trips, equips himself with a valuable knowledge of suppliers' stocks and new sources of supply which helps him to make his contracts and satisfy his special needs to unusual advantage.

In this study, also, the cost of the product to be bought deserves close attention. The question is not merely "What can we afford to pay?" or "At what price will the purchase return dividends?" but also, "What is a reasonable figure based upon

production costs?" Shop investigations give the buyer a shrewd instinct for values and indicate how by changing his requirements he can often reduce cost and price.

Emergency purchases present a slightly different problem than the foregoing. Price, quality and service—the three important elements of any purchase—are almost as easy to satisfy in case of special purchases that can be made at leisure as with routine requirements. The buyer merely rounds out his experience accordingly to methods with which he is already familiar. When the time factor is predominant, however, he often has to "take a chance" on quality or service and the grave nature of the demand may dwarf the consideration of price. How to get price and quality without sacrificing prompt delivery is a task that calls for the highest order of purchasing ability, backed by broad knowledge of the market and cordial relations with all probable sources.

Seldom is a purchasing department so severely tested as was Edison's when late in 1914 fire gutted his plant. Almost before the flames had died away, his buying force was on the job. Within two hours, the very night of the blaze, approximately three hundred and fifty telegrams were sent, most of them carry-

If this Order Cannot Be Given IMMEDIATE RIGHT OF WAY
Telegraph at once at Our Expense.

The material covered by attached Edison Storage Battery Company's Purchase Order No..... is for re-equipping the Plant of the Edison Phonograph Works, DESTROYED BY FIRE, Dec. 9, 1914, and Mr. Edison, personally, and his staff are working day and night on the reconstruction.

The Edison Storage Battery Plant was in no way injured by the fire, and is therefore called upon to help recover, rebuild and install the machinery for the allied companies. Other manufacturers are assisting us to make this a record recovery.

ARE YOU WITH US ALSO? If so, Ship by Quickest Route and Bill to Us

R. A. Bachman, Vice-Pres. and Gen'l Mgr.
Edison Storage Battery Co.,
Orange, N. J.

Form 1169-12-14-1M

FIGURE VI: Printed in red, and carrying a heavy red border, this emergency label commanded instant attention for the order to which it was attached. The emphasis laid on speed, the reason for it and the appeal for enthusiastic cooperation are evident in the words capitalized and underscored

ing either inquiries or orders. Firms with which the corporation had dealt previously naturally were requisitioned first. When these could not deliver, other houses were chosen by reputation or special information. Many concerns wired their readi-

ness to help before even there was time to solicit them. Each confirming order carried a red-lettered sticker (Figure VI). The word "rush" nowhere appears, yet the appeal for the quickest kind of quick service is unmistakable, even electrifying.

And this was the kind of action secured: an order was wired to Providence, Rhode Island, at 2:30 o'clock one afternoon. The shipment was received the next afternoon, with the red-lettered sticker from a previously received order *pasted on the box.*

Though price bargaining was practically ignored in placing these orders, moreover, the frank appeal to suppliers for quick action, on honor as to quality and cost, resulted almost uniformly in the fairest of treatment.

Back of this achievement in purchasing were records, experience, buying power, prestige, good will and sound tactics. The buyer did not wait to be sold. He took the aggressive from the first hour in investigation, decision and action.

In spite of the extreme urgency, moreover, Edison neglected no practicable precautions to insure the quality of purchases which were out of his experience. When in doubt, he paused long enough to make sure. In buying steel sash to replace the wood that had been burned out, although the complement for one building was ordered without any preliminaries, before the general order was placed different manufacturers were invited to submit samples for test. A special test chamber was rigged up, and after the glazed sash had been subjected to a fire of kerosene and celluloid, a hose stream was turned on. The make which stood up best was purchased, notwithstanding it was one of the highest in first cost, and the firm which booked the order reciprocated by filling it in record time.

V

DECIDING WHETHER TO BUY OR MAKE

WHAT to make and what to buy is a question which every change in conditions brings again and again before most manufacturers. Certain portions of the equipment and product it undoubtedly pays to make; certain other portions it is profitable to buy. In between are items that are hard to decide on, and here the question keeps bobbing up. Nor is the calculation of the right way simple. Many other considerations besides price enter into the decision. In some cases it is profitable to pay a little higher price and buy outside; often, however, it is poor business to buy even when the quoted prices are below the home shop's cost (Figure VII).

Business judgment quickly furnishes the answer, where the manufacturer lacks the knowledge or facilities for producing the certain part or the quality desired. A manufacturer of household utensils put on the market a high-grade chafing dish which he furnished in both nickel and burnished-copper finish. He planned to use a dead-black finish wooden handle such as he had used on his cheaper product. Experiments, however, showed that it was very difficult to produce an enamel without gloss and that a shiny handle cheapened the appearance of his chafing dish. Consequently he decided that he could well afford to pay three cents for the handle he desired, purchasing it from a concern specializing in such handles, although his own factory could produce the slightly inferior handle at something below one cent. Here the two cents extra cost was justified by the greater salability of the final product. Many such cases arise, in which minor parts purchased outside at a price much higher than the factory's cost are a good investment.

Another common situation is where a concern is doing a heavy business on small capital. Two young men began to manufacture a line of hardware with which they were fairly familiar. One of them promptly formed selling alliances that loaded their factory with orders which taxed their financial resources to the utmost. Their business was a rather special and hazardous one, and capital, if obtainable at all, was only to be had at a rate unfavorable to a young business. Making the business build up its own capital therefore seemed wise. To do this both the owners cut their personal expenses to the quick. They were buying a lot of punched work and it soon became evident that a modern punch press would be an excellent investment, not only on account of the saving in actual expense, but also on account of the greater control of production it would give and the consequent better deliveries that would result. A little figuring, however, convinced the partners that the money spent for the press, if invested in additional stock or used in similar channels, would yield a much larger return than they could hope for from the new tool. Here was a place where it did not pay to make goods, even at an apparent saving, on account of the money tied up. The same partners found that on many items in their line, if they were to be prepared to fill orders, they had to carry excessive stocks. Some of the articles moved slowly and, if manufactured in anything like economical quantities, left large amounts of dead stock. Here again it was cheaper to buy as needed, even at a higher price and to confine attention to the bulk items of the business.

For somewhat similar reasons a large electrical concern has repeatedly declined to go into the manufacture of porcelain. Porcelain insulators are used in large quantities in their factories and their business is an attractive one for the porcelain factories. It has always seemed to certain of the executives that a porcelain factory should form a part of their plant. The president, after careful study, decided that such a step would be unwise. He found that there were a half dozen factories eager for their porcelain business, and that prices were uniform and deliveries good. Investigation showed that the manufacture of electrical porcelains was a rather difficult technical problem and that the successful concerns had been at it a long time. A further study

backed by some confidential information disclosed the fact that none even of the successful concerns was making large profits and that the average factory which attempted to do business on a strictly competitive basis did so at a loss. As he had a good purchasing department, was the largest buyer in the country, and knew competition among his sources to be free, the president could see no reason for saddling his plant with another industry.

His decision as to a glass factory was quite different. They already had a separate factory making incandescent lamps and buying the glass blanks in the open market, when the mercury-arc rectifier came into the field. In the rectifier a large glass bulb is exhausted, then supplied with terminal electrodes and a small body of mercury. The lamp factory attempted the manufacture and failed. At the main plant a staff of chemists, engineers and research men succeeded in producing a few of the lights. By

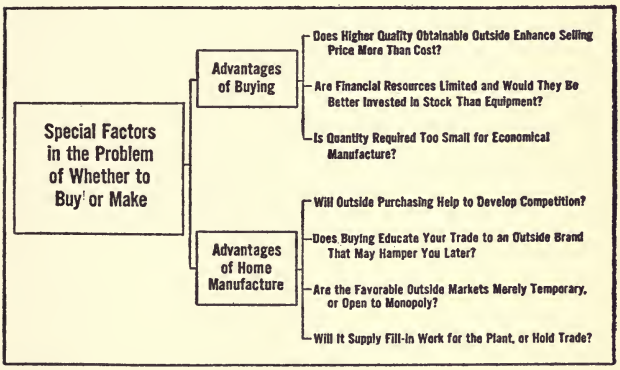


FIGURE VII: In deciding almost any problem of whether to buy or make, certain advantages will suggest buying and others home manufacture. Questions for testing such suggestions are here listed. Obviously, one question will be more important than the others and thus become the deciding one

equipping a small factory and using constant diligence a commercial article was finally produced; and in the course of time the factory was enlarged to a point where the line showed a good profit. Here the very special nature and importance of the work anchored it inside the main plant. It was the exact opposite to the case of the chafing dish handle. In that case quality require-

ments took the business outside, while in the rectifier case the business was forced on the factory itself.

HOW BUYING INSTEAD OF MAKING MAY BUILD UP BUSINESS FOR YOUR COMPETITOR

DUE weight must also be given to the question of building up a competitor. A certain factory has for two generations been recognized as the premier engine builder of the country. For many years the bulk of its business was large engines for heavy power purposes. It bid on complete plants, and these often included small auxiliary engines. Although the small engine business of the country is and was then, very large, this particular concern would not lower its dignity by engaging actively in the business. The result was that most of the small engines were built by a younger and much smaller company, which gained an excellent business and reputation, partly at least from the leavings of the big company. It was not many years before the smaller company began to enter the field of medium and large engines, and it soon became a formidable competitor on the middle sizes of engines. The coming of the steam turbine killed the large reciprocating engine business, and the two concerns are now about equal in size and trade volume. The concern which was originally the smaller is forging ahead, and the larger concern is dropping back. There is only one end to such a story. Here the larger concern voluntarily became a customer of the smaller and materially helped to build up a formidable competitor. It would have been good business policy for it to build small engines, even temporarily at a slight loss. If they had done this, with their experience and reputation, they no doubt would still have a profitable business. In general it is unwise to buy from a competitor. He is your adversary in the business game, and his profits are not only his gain but your loss as well.

Buying outside sometimes helps your competitor even when you do not buy from him. One concern found this out to its sorrow. It used a special form of chain which it produced and which gave its goods a certain distinction in the trade. The principal reason for making this part was that apparently the chain makers did not care to trouble with it, as the process was

a difficult and expensive one. It, therefore, enjoyed practically a monopoly for some years. The high price charged, however, finally attracted the attention of a Connecticut Yankee who devised a set of special tools for producing the chain. But the market was not sufficiently large for him to make much profit unless he charged a good price. After considerable negotiating he persuaded the factory in question to contract with him for a large quantity of the article and, with a good volume of business thus assured, he could afford to make a sweeping reduction in price. He not only interested competing concerns, but in some cases sold chain to such concerns at a lower price than to his original customer. By buying parts outside, the pioneer concern established a factory for the manufacture of such parts and cheapened their costs to competitors.

Again, a supplying factory may be so strongly built up by continued patronage as to be tempted to go into the business of making the completed product. Not a few concerns have found themselves thus suddenly confronted with new and powerful competition and at the same time shut off from a principal source of supply. The astute manufacturer will guard against this contingency either by scattering his purchases widely or by depending on others for such a minor fraction of his supply that not even a merging of their interests—a remote possibility in any event—would furnish him dangerous competition.

What threatened to be a case of this kind with one of the biggest automobile manufacturers in 1914, turned out quite otherwise. For years he had been buying a large number of his parts from one concern. As he grew, so did his supplier. One day the trade was startled by a simultaneous announcement. From the motor manufacturer came the word that hereafter he would make all his own parts; from his supplier, that a new car would soon be put on the market. Rumor had it that there had been a break between the two, and that the supplier would enter the field as a competitor. Consequently, when the specifications for the new car were given to the trade, many were surprised to find that it was in an entirely different class. Later, when the two principal owners of the second firm were disclosed as large stockholders in the first, enlightenment came. Far from being a break, there had been a tacit understanding between the

two companies. The original car manufacturer had simply come to the point where he felt he could make the parts in question cheaper than he could buy them and for years had been quietly preparing to do so. The other, foreseeing this, had been making his preparations also. Each was proceeding with perfect understanding of the other's intentions, and what at first seemed to be a vital mistake on the part of the supplier, proved a loss to neither.

WHEN IT PAYS TO MAKE AND USE AN UNBRANDED DEVICE

ANOTHER instance of unwise buying was that of an automobile manufacturer who placed on his car a patented device furnished outside. Liberal advertising on his part and by other automobile manufacturers established this device in the public eye. Today the car builder pays just twice the original price of the article, and he is further mortified by seeing a fraction of his good money spent in general advertising that makes it out of the question to discard the article. As he puts it, he is an agent working without pay for the maker of the article. He is not the gainer by using the device, as all his competitors also use it. If he could discard it he could materially lower his price and increase his net profits. So it often pays to make and use an unbranded device rather than to come under the control of a patent monopoly.

The circumstances under which a low price is made often call for investigation before the factory determines upon outside purchasing. An umbrella manufacturer had an attractive price made to him for a supply of parts. After purchasing such parts for about a year he dismantled his machinery for making them and used the space for other purposes. Shortly after this there was an abrupt increase in price. Investigation showed that the original price was made to work off a lot of material that had accumulated as a by-product in a highly specialized chemical works. When the accumulation had been disposed of the price went up, and by the time the manufacturer had remantled his equipment he had, in the total, lost money. Before purchasing outside, to the entire exclusion of factory facilities, it is always

wise to investigate the reason for, and the permanence of the low price. Any source of supply that is not permanent is manifestly untrustworthy.

Sometimes factory conditions dictate that an article shall be made at a loss. A good example is the production of knife-switches by one of the big electrical manufacturing concerns. The knife switch is the orphan of the electrical business. Standardized by the National Board of Fire Underwriters, its design is fixed. It must be just so large and constructed in such and such a way. Anyone can make it, so far as the design goes. If the maker follows the Underwriters' specifications he will produce a switch that practically duplicates those of all his competitors. The amount of material required will not vary. It is of simple construction, requires few tools to make and can be produced competitively by anyone having even inexpensive equipment. The business, therefore, is on a very keen competitive basis.

The concern in question had two general outlets for switches. First, it sold switches, mounted on their own bases, for general use; and second, it assembled switches, on switchboards, with meters, circuit breakers, and so on. The first it handled at a loss, the second at a large profit. The switches used in the second business differed slightly from the separately mounted switches and were often special. An investigation showed that the manufacturing costs of the separately mounted switches made by this concern were in excess of the cost of switches bought in the open market. It seemed desirable therefore to buy such switches outside. It also seemed impossible to buy the switches needed for switchboard purposes, due to the variable nature of them. If the regular production of standard, separately mounted switches was discontinued, however, the cost of the switchboard mounted would quite evidently increase, because separately mounted switch work was done for stock and constituted a ready task for men between special jobs.

The question, therefore, was not whether the separately mounted switches could be bought for less outside, but whether the switch business as a whole would not suffer if they were bought. It was decided that it would suffer and that the remedy was not to buy outside, but rather to sell more outside and thus

increase the volume of standard switches passing through the department. A radical cut in price increased these sales and, although resulting in a temporary loss, was soon followed by recovery as the costs fell before better standardized work. This improvement in turn reduced switchboard costs and increased the profits thereon.

To consider one part, therefore, and to base your decision on that part alone, is not always good judgment. Other articles may be linked with it, so that an apparent profit may be a real loss or the reverse. The net total of profit or loss in the long run is the test.

Generally it pays to buy outside when the market will supply the articles you need, in the proper quality and at an attractive price. It is not profitable to patronize competitors, or to broaden a market and lower prices where they buy. It sometimes pays to manufacture parts at a loss or to buy parts at a loss, if a higher selling price can be thereby obtained for the assembled article. Low prices quoted by outside manufacturers should be scrutinized to see that the concern making the bid is responsible and that the prices quoted are likely to be permanent. And finally, while costs can be determined accurately, the cost of one article may be increased when you cease to make another. Costs are interdependent and not fixed, as is often imagined. Broadly speaking, a low quotation from outside should be carefully considered before you purchase articles that could be made. That you can produce parts more cheaply than you can buy them, however, is not always a conclusive reason in favor of home manufacture, nor when the conditions are reversed, that you should always buy rather than make. Broad policy considerations underlie the decision in the last analysis.

VI

HOW PRICE AND SERVICE ARE SECURED

SAGACIOUS buying wins the minimum price with the maximum service. It is a study of conditions from the viewpoint of the other man. It is gaining a definite advantage by knowing what the firm from which you are buying can fairly afford to do in the matter of qualities, prices and deliveries. There are always methods of making an order easier to handle, more desirable to the source and less open to sales tactics that border on unfairness.

Mastery of conditions and an analysis of the other man's attitude are the essentials of good buying. The general manager of an ore-boat line sent to the four big ship-building concerns in his Great Lakes city this invitation:

"Can you have a representative in my office at ten o'clock Thursday, prepared to submit a figure on two ore boats? As you can see from the specifications herewith, the new boats will be practically the same as the last one we had built."

Now, ore boats cost about two hundred thousand dollars and an order for more than one was then so unusual that the selling chief of each of the four companies responded in person. The usual custom was for the buyer to talk to each builder individually, compare the prices item by item and award the contract at his leisure. Each representative counted on a quiet chat with the manager, a discreet effort to learn what other bids were in and an offer calculated to secure the order with the least possible sacrifice of profits.

On the appointed day, however, the last of the four had arrived before the first comer was admitted to conference. While wait-

ing, therefore, each went over his bid carefully. He revised his figures wherever he had been liberal in his estimating and also shaved the margin of profit all he dared to. Each knew the thorough reliability of his competitors and the exactness of the specifications as to materials, workmanship and time of delivery. All saw that price, based upon economical facilities and good organization, must win.

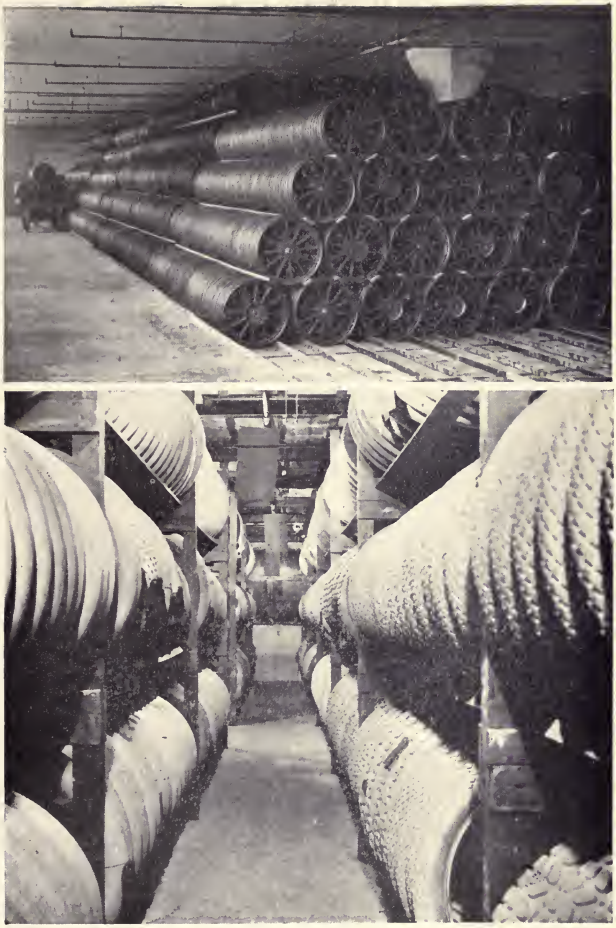
In a few minutes, the first man to enter emerged with a broad smile. Much to his surprise, the manager had accepted his tender and signed the contract on the spot. Though his figures were less than the successful bid on the one boat previously built, still he could not quite understand why he had received the order before his competitors were heard. He could scarcely credit his good fortune.

So the other three in turn were admitted to audience, and as each reappeared with a well-satisfied expression, the others went over their bids still more carefully.

That more than two boats were contemplated did not enter their minds. Had it done so, the temptation would have been strong to collude, so that each could carry away an order for at least one boat at a good price. But all felt that two of the four must go away without business, and each was determined not to be one of the two. When the last one had his tender accepted, he was at a loss to understand the elation of the first three.

Next day came revelation. All four had won. The ore line had ordered eight boats instead of two, and had bought them for several thousand dollars below the previous level of prices. But the manager had done much more: by committing the company only to a two-boat program, he had placed an order taxing the capacity of all the yards without paying a premium to any. Had the least hint reached the builders that there was work for all, the revision of prices might have been just as vigorous, but upward.

Here was business strategy in the concrete—an instance where grasp of all the elements of a problem enabled one man to keep the transaction on a basis of fair competitive prices in spite of conditions that favored a salesman's market. The manager's plan had knowledge for its basis—carefully correlated facts bearing on the equipment and capacity of the various yards, the



To insure against production difficulties in factories which are sources of supply and against delays in transportation, calls for reserve stores at all times. Wheels ready for assemblage at the Ford plant are shown at the top. Precautions against deterioration of stores is illustrated in the dry vault for tire storage at the Jeffrey plant, where a uniform temperature of 50 to 55 degrees is maintained

Scientific management investigators like to begin in the stores department for which the darkest corner in the plant has often been selected and where only a long memory can locate stores. How these methods are passing is indicated by the labels in the storeroom (top) at the Vulcan Iron Works, and by the light, ventilated storeroom (below) material at the George M. Pierce Company

customs and precedents of the trade which guided action, the very temperaments and habits of thought of the different managers. He had studied the situation from their viewpoint as well as his own. Against the company's immediate needs and the sky-rocket effect an eight-boat program would have on the market, he balanced the fact that no order of such size had ever before been placed, and the certainty that the builders, asked for figures on two boats, would assume that only two were to be constructed. On two steamers they would compete; on eight, combine. The essential thing, therefore, was to keep secret the company's desire for a fleet, and prevent the builders from comparing notes until all the contracts had been signed.

This was million-dollar strategy directed towards a specific and immediate end. Once employed, its usefulness in exactly the same form was ended; but the method, the underlying strategy, can be applied in the conduct of the smallest factory. The more successful an individual organization, the more certain it is that analysis will discover in the management the exercise of this generalship in policies and campaigns, in swift "strokes of luck" or dazzling "inspirations" which may have been planned months before.

The idea behind this plan is of universal application; it is to find and build up sources of supply by fair prices and contracts, but to protect your firm at the same time against prices that are based on the stringency of demand rather than costs. Such buying also benefits the supplier. It sharpens his wits in devising new economies in manufacture and so promotes efficiency.

Coal is raw material for the Commonwealth Edison Company. For several years "screenings" have been in exclusive use. The development of the automatic stoker made it practical to burn this fuel, which formerly had been a worthless by-product in the production of lump coal. Its adoption by several large companies in the Chicago field naturally gave it a substantial market value. At that time little coal was purchased from the mine direct. Jobbers controlled the mine output and their habit was to ship the coal into Chicago and then hustle around to find takers. The entry into the market for screenings of so many big companies prompted a coalition among the jobbers to control

the prices. The purchasing agent of the Edison Company was among those caught the first time. That winter, however, he laid in a heavy reserve supply, as in the cold season the production of screenings is considerably in excess of the demand and they sometimes can be bought for the freight charges. This supply he used throughout the ensuing year as a leverage to bring the jobbers to time.

Counting on the Edison Company's steady requirements they continued to ship in so many carloads a day. The purchasing agent refused to buy for several days and meanwhile the demurrage charges piled up on the jobbers. Finally, when they were willing to sell at any reasonable price in order to avoid further loss, he began to buy again. Although the Edison Company now contract for their coal by the year directly with the operators, and buy of the jobbers only when they can better the contract price, they still accumulate a large reserve when the price is at rock-bottom. But they do so for a different reason mainly. Of course, a reserve is always a protection against an unforeseen interruption of the supply. To lower the yearly average price of the coal is, however, the principal reason. Moreover, it is still a protection against conditions that favor the jobbers in case they have to supplement their regular supply at any time.

HOW FAR TO TAKE ADVANTAGE OF LOW MARKETS AND WHEN TO PASS AROUND SUCCESS

IN another case, a firm had inquiries out for a thousand tons of special, gray iron castings—a most desirable order. Several representatives appeared in person and many other bids were received by mail. The bids were low in price, but the buyer was not satisfied. In conversation with one of the bidders who was out on the question of delivery, he learned that one foundry had no work ahead and was anxious for the contract. Their bid was in and was one of the low ones. The representative explained that, casting prices being made up of cost of material, freight, labor cost, overhead charges, and profit, the last two were the only ones which could be cut. He also said that the times being so bad nearly all the foundries had cut the profit to little or nothing. He intimated that his foundry, rather than lose the order, might be willing to cut its profit to almost nothing. A

wire was sent offering them the contract at $1 per ton under their bid. This was accepted, making a saving of one thousand dollars.

Just how far a firm is justified in taking advantage of a supplier's stringency to exact an unusual price concession, is debatable. If the supplier loses money on your order, he is fairly sure to exact a double profit when he gets you at a disadvantage. That a number of large manufacturers have adopted the policy of buying on a cost-plus-a-percentage basis or of seeing to it that no supplier handles their business at a loss would indicate that they believe it to be more just, and in the long run more profitable, to "pass around success."

Large companies, dependent as they often are on a few suppliers for some material which they consume in enormous quantities, are at a disadvantage. The buyer must, therefore, exercise the utmost vigilance and foresight. He faces a practical monopoly, and only by the keenest kind of generalship can he keep the scale even. Small companies are in a better position because with any single commodity, one of several competing concerns can meet their entire requirements. If a large company can develop one source of supply to the point where this alone is sufficient, it then has a peculiar advantage, provided there is sufficient possible competition to keep the favored supplier appreciative. Otherwise, the development of a proprietary source may be the only way out.

HOW TO DEVELOP COOPERATION IN DEALING WITH AGENTS AND SALESMEN

BULKING purchases with one or a few suppliers is the modern tendency in purchasing. This policy has many advantages. When there are fewer firms to deal with and fewer salesmen to see, more intimate relations can be built up, better prices secured and purchasing expense reduced. However, like all moves in the right direction, this one can easily be carried too far. The favored suppliers, presuming on your good will, may after a time grow careless. Moreover, some of them may be outdistanced by competitors whom you do not recognize. Thus by adhering too tenaciously to a policy of concentrating your purchases, you may presently find yourself paying a higher price for an inferior article and have lower service to boot.

No matter how reliable a firm is today, next year or the year after developments and changes in the market may have transferred the greater reliability elsewhere. So it does not pay to become too firmly committed to any one source. Divide up your business just enough so that the favored supplier will be kept constantly appreciative. Let him plainly understand that you patronize him because it is to your advantage and never hesitate to shift your favor if you find another firm more worthy of it. The guiding principle is to keep your buying on a merit basis strictly.

This does not mean that friendly relations with the trade are to be discouraged. Some buyers fear that the development of friends among salesmen will lead to conditions unfavorable to businesslike buying. This is far from the actual fact. A wide acquaintance is as valuable to the buyer as to the salesman. The buyer with many friends among salesmen is not apt to be unduly influenced by any one man's personality. The one who has few friends, however, is much more likely, in a weak moment, to let a strong personality dominate him to the point of closing an unprofitable deal. Wide acquaintance and a regular practice of keeping in touch with the representatives of all potential sources are the surest methods of avoiding the pitfalls of personal favoritism.

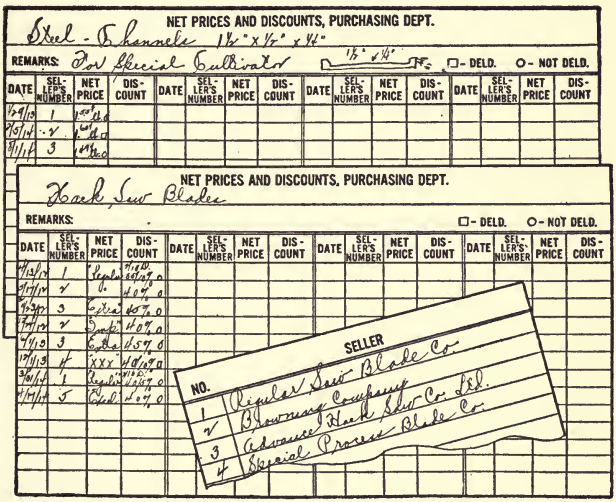
"A purchasing agent may add to his buying staff every salesman who calls on him if he will take the initiative and handle his work on that basis," says a buyer known for his ability in finding and bargaining for what his house wants. "Yet every so often one meets a buyer whose business it is to spend his employer's money to the best possible advantage, but who feels that he can serve this end by being a human icicle and frowning on the salesmen who call on him."

Moreover many a buyer has been caught in an emergency and made to pay dearly for his lack of courtesy, when, if the salesman had been treated with decent respect, he would have helped the buyer out of his trouble with reasonable prices and quick deliveries.

A salesman representing a jobber who carried a stock of merchant steel had called several times on a self-sufficient, "busy" purchasing agent, whose factory required sheets in large quan-

tities. This buyer made all of his purchases from the mills in carload lots and evidently felt that he would never need deliveries from stock. For this reason, probably, he had treated the salesman brusquely. But one morning the jobber's man, while waiting in the outer office for an interview overheard a remark which showed him that the buyer was in a tight place. Three carloads of sheets had been lost in the floods in Indiana and the mill would have to shut down unless another supply could be found.

When the salesman entered, therefore, he found a very pleasant reception awaiting him. He had nearly a carload of the size of sheets required. He sold them, but at a price so far above


NET PRICES AND DISCOUNTS, PURCHASING DEPT.

REMARKS: □ - DELD. ○ - NOT DELD.

DATE	SELLER'S NUMBER	NET PRICE	DISCOUNT
1/3/18	1		
7/3/18	2		
9/1/18	3		

NET PRICES AND DISCOUNTS, PURCHASING DEPT.

REMARKS: □ - DELD. ○ - NOT DELD.

DATE	SELLER'S NUMBER	NET PRICE	DISCOUNT
7/3/18	1		
9/1/18	2		
7/3/18	3		
7/1/18	2		
7/1/18	3		
12/1/18	4		
3/1/19	1		
7/1/19	5		

SELLER

NO.	
1	Regular Saw Blade Co.
2	Browning Company
3	Advance Hack Saw Co. Ltd.
4	Special Process Blade Co.

FORMS III–V: Prices and terms are recorded from the invoices. The rest of the data is added partly from the purchase order and partly from the material-purchase record (Form II). When any item is discontinued, the card covering it is placed in a "dead" file, for future reference, if necessary

the market that he felt called upon frankly to explain the reason. The buyer learned his lesson and treated this particular man in a different manner thereafter.

Courtesy in the handling of salesmen naturally develops

cooperation. A man who sells a line of material is thoroughly familiar with it and can help the buyer in many ways. In addition, he is able, through his rubbing against salesmen in other lines, to know much about other men's business. The representative of a paint house discovered that one of his customers bought largely of black iron wire from the mills in standard length coils. This was afterward cut into short lengths for use. The salesman learned that a certain mail-order house bought short ends from the same mills, fifty or a hundred feet long, put them up in hundred pound coils and sold them at approximately half the market price. He told the buyer of this, who thereby saved many hundred dollars yearly on his wire.

It may be laid down as a safe rule that it pays to get on personal ground with those with whom you do business. There are always advantages to be gained by such a policy. It is the surest way of learning trade customs. It gives one a broad outlook on general business conditions, and on practical factors affecting business. Credit information may be gathered in this way. A salesman is always anxious to get a prospective buyer favorably disposed to him, if the buyer shows a human side. A friendly salesman, too, is a valuable help in getting action from his house in case of emergencies, slow deliveries or adjustments of any kind.

One buyer through an error in his factory, ordered nearly twice as much special machinery as he needed. A wire summoning the salesman from whom he had purchased brought the information that the special patterns had been made and the castings poured. The castings could be melted up again, but the labor on them amounted to about $500. This buyer had won the friendship of the salesman, had helped him in getting other jobs and now asked him outright for assistance in getting out of the hole. Just what argument the salesman used on his house, is not known, but the superfluous part of the order was cancelled without cost to the buyer.

A requisition for a small quantity of wire rope of special construction in another instance was misplaced in the purchasing department and came to light only a few days before the machine on which it was to be used was to be shipped. The case looked hopeless, but the buyer had cultivated the salesman of the cable

house which supplied him. He told his trouble to this man over long distance and on the day it was required the material was on hand. The salesman had gone personally to the mill, had had the rope machines set especially for this job and the one hundred and fifty feet of rope was billed at the regular price.

Generally speaking, however, it is not safe to rely unduly on the good will of salesmen and suppliers. Though a highly desirable adjunct, cordial relations with the trade are not a substitute for thorough preparation. In the first place, the buyer must have plenty of time in which to secure competitive bids and be assured of his sources if he is to get both price and service. If he has to buy on short notice he cannot usually go to the mill or factory direct, but must do the best he can with jobbers. He should, moreover, have his lists of possible sources handy for reference and replete with purchasing facts, indicating a record of past performances. Then he is fortified to secure reliable quotations promptly.

To fortify the buyer as strongly as possible in this respect, the A. B. Farquhar Company maintain card index records of every item purchased (Forms III, IV and V). One subject only appears on a card. Net prices or discounts, terms, sizes, grades, mill or stock shipment, sketches, a list of suppliers for the item in question—all are given. Quotations for future consideration may be entered in red ink. The names of the suppliers appear only on the back. Each is given a number and this is used to key the information on the front face. Space is thus saved on the front and also the combination of price and seller prevented from becoming known should the card be exposed to the view of any interested person. Except in the case of special articles manufactured or sold by only one firm, the information on these cards keeps on expanding as new competition enters the field. The "other fellow" is always given a chance to quote, and in time his name will be added to the list.

Summed up, getting price and service is no more than knowing and planning—knowing more than the other fellow and basing on this information a definite program or policy calculated to accomplish a certain result.

Knowledge of your own business is the first requisite—its needs, its resources, its present possibilities, the opportunities or

perils which the future or an untried field may hold for it. Analysis of trade and market conditions comes second, coupled with the study of the personal equation in each case, the other fellow's side of the question and the personal traits of sales representatives whose friendship may save you in an emergency.

Finally, plans. Plans based on these correlated facts—a program employing every important resource, missing no fortuitous chance, betraying no vulnerable spot, safeguarding the future while seizing the current advantage, capitalizing advantages in which both source and purchaser will share, keeping always a move ahead of the absolute requirements of your plant.

VII

RECEIVING AND INSPECTING PURCHASES

SHORTAGES of supplies and materials, the blind search for mislaid items and the delays that result from the loss of invoices characterize the ill-managed receiving department. These difficulties often interfere with production and make the collection of claims for damage to goods in transit, as well as the correction of the supplier's mistakes in count, weight and quality, all serious matters. To avoid the resultant losses correct checking when the goods come in and quick, accurate distribution of the goods to the proper departments are necessary.

Something more than counting, measuring and weighing, however, is involved in the receiving of goods. Lumber may meet the specifications as to length, width and thickness, but yet prove a baffling problem as to inspection for knots, uniformity of grain and the other points where a difference of opinion so often comes up in grading. Ore, leather, steel, chemicals, clay, similarly call for the services of the physicist and chemist to back judgment with laboratory evidence.

In providing for incoming shipments the first thing to do is to arrange for the delivery of materials through one inlet; then to weigh, measure or count and carefully inspect for defects, each lot as received; and to record the details of the inspection for use by the auditor in paying bills, the cost department in accounting for the disposition of the materials charged to the shop, and the production department in putting the articles into immediate use. A blank (Form VI) commonly used for this purpose is made in triplicate. One copy goes to the cost clerk for attachment to the invoice when received, one to the pro-

duction department as notice that the material is ready for use, and the third is numbered serially and kept on file by the receiving clerk to assist in discovering stray articles received without prompt advices. Having checked in the articles, each lot is promptly to be put in its proper place, regarding which the system should be so good that there is no doubt nor hesitation as to where it should go.

The purchasing agent keeps tab on deliveries by filing a copy of the requisition for supplies in a date "tickler" under the expected invoice date of the item called for earliest, and noting this date on a record copy of the purchasing order. Each day the removal of the front card shows up the requisitions for articles, invoices for which should be received that day. According to requirements, the sellers may be written or telegraphed, allowed a day's grace, called on to delay shipment, or left to their own time. Invoices received are delivered first to the purchasing agent to check prices and discounts, and to remove from his "tickler" the corresponding requisition. In case of a shipment far ahead of the expected date, the requisition may readily be located by the date of shipment expected, as entered on the order copy, which is already at hand to check the prices. With the checking of the invoice, and the entering of the price details on order record book or order copy, the purchasing agent's work on the particular transaction is ended.

From the purchasing agent the invoice goes direct to the cost clerk, where the receiving memorandum is attached as soon as it comes in, and the total net price, including freight and miscellaneous charges, is entered on the material inventory ledger, or, if separate inventory cards kept in the stock-room are used, in a material price book. This price is made fractionally higher, sufficiently to take care of odd cent fractions, or to cover shrinkage in substance where it occurs, but not enough to expect a profit in the material account. In case of articles like small screws, it is necessary to carry price-sheets for lots of one up to a dozen or more, to facilitate calculation in cent fractions. In large works it is often desirable to require invoices in duplicate, so that one may always remain in the treasurer's office for reference, while the duplicate goes the rounds. Having taken

off his records, the cost clerk sends the invoice to the treasurer, with the receiving memorandum attached.

In-shipments under the foregoing system all must pass through one inlet. Another concern, however, has developed a very efficient system under which goods are checked in and reported by each department. Shippers in the first place are

Receiving Memorandum

Covering One Shipment Only

No. 2537

Date _____ 19____

Quantity	Size	Description	for	Delivered to

Received from _____

Via _____ Charges $ _____

FORM VI: A receiving memorandum on which is noted the receipt of one shipment only with data concerning its quantity, size, description, supplier, route, charges, and the name of the department in which it is to be used, is here shown

requested to make out their invoices in triplicate, mailing them direct to the purchasing department. When they are received here, the items on the invoice are entered in a book properly ruled for that purpose, showing the number of the requisition for which the goods were ordered, the department they are intended for, the date, from whom they are received, terms of purchase, how shipped, and if by car, the car number. If the bill provides for a discount, it is so stamped. The same stamp shows also the date of maturity. Every invoice is given a distinguishing number which is entered in the record book. At the same time the requisition is checked and the price marked "O. K."

If three copies of the invoice are received at the purchasing department, they are forwarded to the auditing department as soon as the above information has been recorded.

In some instances, however, shippers may neglect to send

more than one copy, in which case the two duplicates should be made in the purchasing department. It may seem more desirable always to make the duplicates here, and if such is the case it may be a convenient scheme to copy discount bills on colored paper, so that they will attract attention in the auditing department and insure payment before maturity.

When the three invoices are received by the auditing department, the extensions are carefully examined, and the amounts recorded. Then one copy is sent to the department receiving the goods, one to the storekeeper, and one is retained by the auditor.

When the goods specified on the invoice are received by the proper department, the department head signs a report or receipt for the goods, attaches to it the invoice, and thus approves both at the same time. If there are any discrepancies between the report and the invoice, he makes a note to this effect on one of them. In either case he forwards the report, with invoice attached, to the storekeeper. Upon receipt of this the latter attaches to the report of the department head his own copy of the invoice, and places it in a file. The approved invoice from the department he returns to the auditor. The original invoice, it will be remembered, has never left the auditing department, but the duplicates have been the means of securing the information requisite to the payment of the bill. The wisdom of giving the invoice a distinguishing number when it first arrives in the purchasing department is evident, as identifying it completely from any other invoice of the same date, commodity and shipper. With the invoice fully approved the auditor notifies the purchasing agent that "Invoice No.... from ..... Amount ..... has been paid this date, voucher No...." Thus a triple check on all outstanding invoices is completed.

HOW TO MAKE REPORTS ON GOODS WHEN THEY ENTER THE PLANT

WHILE this system assures prompt and accurate dealing among all the departments handling the invoice, an important incidental step in the receiving of in-shipments is the making of reports when goods first enter the plant. In large concerns this may best be handled by having at the storeroom where the loaded wagons first enter, a pad of consecutively

numbered report blanks. As the wagon enters, the sub-storekeeper records on one of these blanks the contents of the load, weighs the load if necessary, gives the report to the driver, and directs him to the proper department. The sub-storekeeper retains a carbon copy of this report at the storeroom, and by

GOODS RECEIVED RECORD

Received from _____

Address _____ In Transportation Charges _____

Date Received _____ Time Received _____

Amount Received	Description of Goods

Received by _____ Checked in Stock by _____ Entered on Records by _____

FORM VII: Records of goods received, when conscientiously kept, have considerable practical value. This form is used when the shipping department also acts as a receiving department. It is made out in duplicate, the carbon being retained and the original attached to the goods and sent to the stock-room

comparing these occasionally with the reports which have been returned with approved invoices, an additional check is available.

Shipments arriving in carload lots are received by a single clerk, who reports the contents of the entire car, assigns to each department the material belonging to it, and demands, of course, a receipt to assure his own protection. The reports being consecutively numbered afford a check upon the receiving clerks, and any soiled or cancelled blanks must be turned in to complete the records.

Except in the large organizations, it is perhaps customary to have the receiving and shipping done by the shipping department. In such cases the shipping department simply makes out a goods-received ticket (Form VII) in duplicate, showing the number of

boxes, barrels and crates received. The duplicate copy should in all cases be retained by the shipping department and filed according to the date the goods are received, or alphabetically according to the name of the concern from which the goods were obtained. Such a routine will insure in all cases a correct record of receipt. The original should be sent to the proper stock-room or department, attached to the goods.

With this arrangement the goods are not opened in the shipping department. Their receipt is merely evidenced by the clerk when he makes out a goods-received ticket.

This plan as outlined has three excellent features:

(1) Inasmuch as all goods would necessarily have to be verified after reaching the stock-room, by counting and checking, the same operation in the receiving department amounts to an exact duplication of work with the additional cost of labor involved.

(2) The opening of goods in the shipping department would require additional floor space and benches, which is duplicated in the stock-room.

(3) Goods if opened in the shipping department are more liable to be stolen in transit to the stock-rooms.

One particular advantage gained by maintaining a regular receiving department where goods are inspected, counted and weighed as soon as received is that it furnishes an additional check on receipts. In cases of disputes with outside concerns as to amounts delivered, the records of this department furnish the most reliable evidence that reasonably can be obtained. This plan also satisfies the management that goods received are being properly accounted for by two distinct departments. In the last analysis too much cannot be said for the double check, when its cost of maintenance is not out of proportion to its value.

Where a regular receiving department is maintained, and especially in large plants where there are many different stock-rooms and large quantities of special goods handled, that department ought to be furnished with a copy of every purchase order issued, showing by whom goods are ordered. This is filed alphabetically according to name of requisitioner so that the goods may be forwarded without loss of time to the stock-room ordering them.

By using strip carbon paper everything specified on a pur-

chase order may be copied on a duplicate order except the quantity and price. Since neither of these items concern the receiving department directly, it is generally held that they should be omitted. However, some managers contend that it is a better policy to insert quantity and price in the copy for the receiving clerk.

An excellent plan to accomplish this is to make the copies furnished the receiving department serve as goods received tickets but leave the date received and the quantities to be filled in by them. This eliminates entirely the extra labor and expense of making them out in their entirety in the receiving department.

VIII

PURCHASE FORMS AND SYSTEMS

SALESMEN spoke of a certain purchasing agent as a shrewd buyer. On being questioned in this direction he attributed his reputation for "shrewdness" to the diligent use of a purchasing quotation record (Form VIII), which carries on one card all the essential details of quotations from various suppliers upon the one item under which the card is filed. His usual procedure, whenever a quantity of anything has to be bought, is to write letters to at least four or five firms requesting them to quote and as their figures are received they are listed on the "Purchase-Quotation Form." When all the quotations are in, he decides who shall have the order, at the same time makes an entry on the card in the "Remarks" column.

After the transaction is completed, this card is moved to the "old quotation file," as possibly a year later it may be necessary to solicit prices on the same or a similar article. The old records will then prove of value for reference. They are also valuable because of the lists of names they contain, should such a list of sources be wanted in a hurry for any reason. When the average purchasing agent gets instruction to buy something a little out of the ordinary, he generally spends considerable time in getting together a good list of prospective bidders. Indeed, there is often a great deal of labor spent in finding out who makes or sells certain things.

The first form illustrated is used for taking quotations on staple articles, while a similar one (Form IX) comes in handy for listing prices on special articles.

When the prices for different quantities have been listed in

System in caring for in-shipments can usually be relied upon to cut down production costs in most plants. This view shows the location of the receiving clerk and inspectors with their records opposite the car door at which freight enters. One inlet with the gate-keeper is accepted as the beginning of good storekeeping in most plants. Department signs make for efficiency when easily read and hung in the open

While the commission man is figuring fewer shifts because of the perishable nature of fruit and produce, the steel mill executive is making an effort to cut costs by placing in-shipments strategically in the first handling from the car. Pig iron is stored directly at the left of the charging floor and scrap is brought directly to the cupola in trucks which serve also as storage bins

the proper column, this card is especially valuable for comparing the prices from different firms, quantity for quantity.

Both of the forms illustrated are especially handy in taking telephone quotations, since the headings at the top of the columns serve as reminders of the vital questions that must be answered. With one of the forms in front of him when he is getting telephone quotations, the purchasing agent avoids having to call the seller the second time for additional information. Nor does he

ARTICLE Machine Screws, Iron "10-32 x 1" QUANTITY 50 Gross

DATE	NAME OF FIRM	ADDRESS	LIST	DISC.	NET COST	TERMS	F. O. B.	DELVY.	REMARKS
1/5/13	Nixon Screw Co	Hartford, Conn	$.85	50/10		2/10	Fact	Stock	
2/14/14	Erie Mch Screw Co	Rochester, N.Y.	"	"		"	"	"	
2/16/14	Clifton Screw Co	Chicago, Ill.	"	50/10/10		"	"	"	Factory New England
2/19/14	Michigan Screw Co	" "	"	"		"	"	"	ordered 3/11/14

ARTICLE Bushing per drawing A.2468 QUANTITY Steel

DATE	NAME OF FIRM	ADDRESS	1 M	5 M	10 M	PRINT RET'D	REMARKS
"/1/14	Howard Mch Co	Chicago, Ill.	5.00	4.50	4.00	✓	
"/1/14	Drummond Mch Co	" "	5.65	5.60	5.50	✓	
"/2/14	Jerris Mfg Co	Cleveland, O	5.00	4.60	(3.75)	✓	Ordered "/9/14

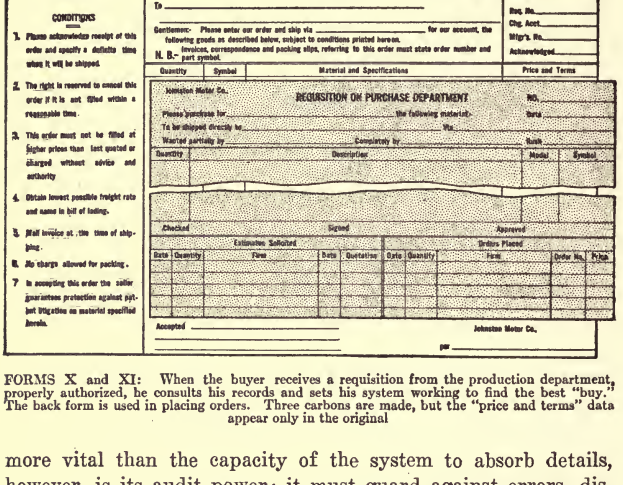
FORMS VIII and IX: One purchasing agent records quotations on staple articles on the upper form, and quotations on special articles on the lower form. Besides forming a valuable record, these cards act as an order on the stenographer to write to the firms listed for quotations

get figures mixed or interchanged as he did when he tried to keep the information on pieces of scrap paper, or in his head.

This buyer is considered shrewd, not because of any marked degree of ability in comparison with other buyers, but because he is systematic in his work, has the complete history of every quotation he receives at his fingers' ends and also because he is a good advertiser—that is, he never fails to let the salesmen who call on him know that he is taking competitive quotations.

Only when the hundreds of details to be kept track of in connection with prices, sources of supply, delivery dates, catalogs

and quotations have been organized into a carefully planned system of record, can the purchasing agent see his way. Every buyer, even for the small shop, knows that the detail which it seems unavoidable to carry in mind is at best a burden. Still



JOHNSTON MOTOR CO.

Pittsburgh, Pa. _____ 191_

To _____

Gentlemen:- Please enter our order and ship via _____ for our account, the following goods as described below, subject to conditions printed hereon.

N. B.- Invoices, correspondence and packing slips, referring to this order must state order number and part symbol.

PURCHASE ORDER
NO. _____
Req. No. _____
Chg. Acct. _____
Mfgr's. No. _____
Acknowledged _____

Quantity	Symbol	Material and Specifications	Price and Terms

CONDITIONS

1. Please acknowledge receipt of this order and specify a definite time when it will be shipped.
2. The right is reserved to cancel this order if it is not filled within a reasonable time.
3. This order must not be filled at higher prices than last quoted or charged without advice and authority
4. Obtain lowest possible freight rate and name in bill of lading.
5. Mail invoice at the time of shipping.
6. No charge allowed for packing.
7. In accepting this order the seller guarantees protection against patent litigation on material specified herein.

Johnston Motor Co. REQUISITION OR PURCHASE DEPARTMENT NO. _____ Date _____

Please purchase for _____ the following material:-

To be shipped directly to _____ Via _____

Wanted partially by _____ Completely by _____ Rush _____

Quantity	Description	Model	Symbol

Checked _____ Signed _____ Approved _____

Estimates Solicited				Orders Placed					
Date	Quantity	Firm	Date	Quotation	Date	Quantity	Firm	Order No.	Price

Accepted _____

Johnston Motor Co.

per _____

FORMS X and XI: When the buyer receives a requisition from the production department, properly authorized, he consults his records and sets his system working to find the best "buy." The back form is used in placing orders. Three carbons are made, but the "price and terms" data appear only in the original

more vital than the capacity of the system to absorb details, however, is its audit power; it must guard against errors, dishonesty and lack of judgment, both in requisitioning and in buying.

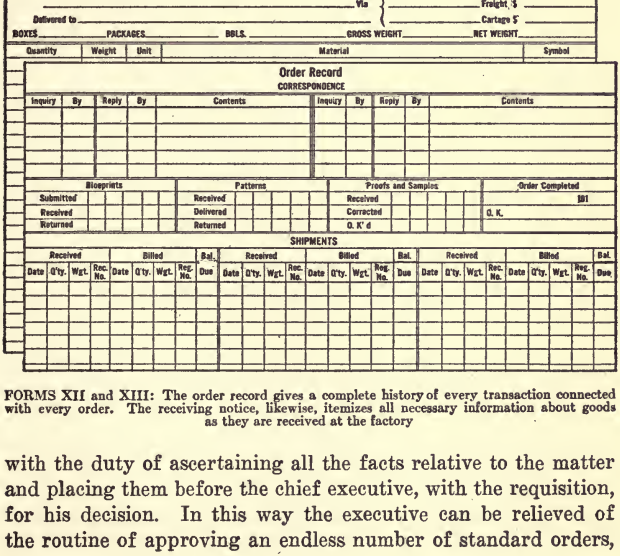
A DEFINITE POLICY FOR HANDLING REQUISITIONS PREVENTS LOSSES AND CONTROLS WASTE

QUESTIONS of policy as well as of method are to be answered. Where, for instance, can the line be drawn between what requisitions should be passed for purchase immediately and those that should undergo a closer scrutiny? If the questioning becomes so rigid that a foreman hesitates about asking for things because he always expects to be turned down, many profitable supplies will be neglected. On the other hand, if every request

were passed without comment, the abuse of the privilege would soon become a source of great expense and the shop would be cluttered with worthless articles.

The disposition of a large share of the requisitions can be left to well-trained subordinates, who should be capable of exercising satisfactory judgment in the matter of standard supplies and minor replacements. Moreover, they should be charged with the exercise of intelligent scrutiny of these orders, as well, so that in case there is an increased consumption due to a poor grade of supply, or to a growing habit of wastefulness, they can take steps to report or correct the trouble.

In any case when a requisition comes through for an unusual article, the routine purchasing department should be charged



JOHNSTON MOTOR CO.

Receiving Notice

NO.

(Invoice No.)

From on Purchase Order No. Date

Via Express $ Freight $ Cartage $

Delivered to

BOXES PACKAGES BBLS. GROSS WEIGHT NET WEIGHT

Quantity	Weight	Unit	Material	Symbol

Order Record

CORRESPONDENCE

Inquiry	By	Reply	By	Contents	Inquiry	By	Reply	By	Contents

Blueprints		Patterns		Proofs and Samples		Order Completed
Submitted		Received		Received		191
Received		Delivered		Corrected		O. K.
Returned		Returned		O. K'd		

SHIPMENTS

Received				Billed				Bal.	Received				Billed				Bal.	Received				Billed				Bal.
Date	Q'ty.	Wgt.	Rec. No.	Date	Q'ty.	Wgt.	Reg. No.	Due	Date	Q'ty.	Wgt.	Rec. No.	Date	Q'ty.	Wgt.	Reg. No.	Due	Date	Q'ty.	Wgt.	Rec. No.	Date	Q'ty.	Wgt.	Reg. No.	Due

FORMS XII and XIII: The order record gives a complete history of every transaction connected with every order. The receiving notice, likewise, itemizes all necessary information about goods as they are received at the factory

with the duty of ascertaining all the facts relative to the matter and placing them before the chief executive, with the requisition, for his decision. In this way the executive can be relieved of the routine of approving an endless number of standard orders,

and yet feel that his departments are not calling for a quantity of unnecessary supplies.

Some executives, however, believe it a valuable check to approve personally every requisition to purchase, even though the signing is largely perfunctory. By carefully reviewing one of the requisitions now and then, they secure almost the same moral effect, so they believe, as if they checked every one. The man who first approves the requisition has no means of knowing which one his superior will check closely.

Dishonesty and lack of judgment in buying must further be provided against, even after the requisition has been approved. One plan to this end is to purchase supplies and materials upon specification wherever possible. In other instances, committee purchasing rules; engineering, sales and operating departments are represented on a committee of which the purchasing agent is the chairman. The different interests then serve as a check upon one another in judgment as well as honesty. Committee purchasing is unnecessarily formal for small-quantity buying. The purchasing agent rarely goes into the market on large or unusual purchases, however, without authority from such a committee or from the chief executive.

The system planned by a western manufacturing concern is modeled to care for purchasing details very thoroughly, and at the same time with a minimum of clerical labor. Quick disposition of every matter, with means for instant reference in case of need, are the points that this system has specially aimed to secure. The purchasing agent keeps his desk free in the current of detail that threatens to choke it up, by dispatching everything quickly and methodically. There is one place for every record, one method of doing every task.

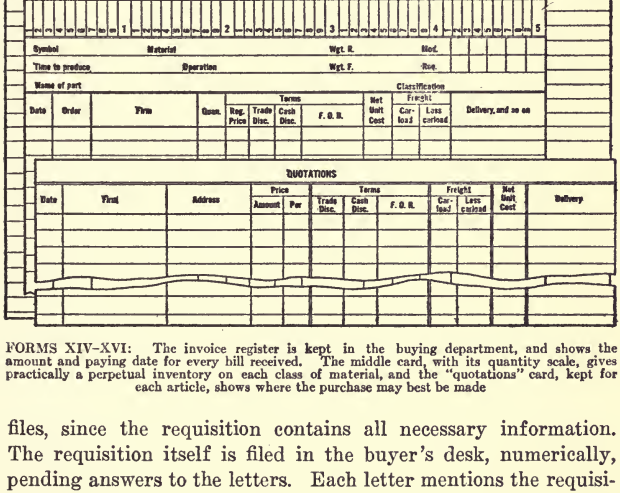
Requisitions from the production departments give the purchasing agent his instructions as to what material is to be bought, and each requisition starts the machinery of his office working to find the one best "buy." These requisitions (Form X) are honored only when signed by the person in each department who has authority to direct purchases.

All detail and information requiring entry are incorporated on one sheet on the form shown. It performs the triple function

of a complete purchase requisition, an inquiry and quotation record, and an order and price record.

When a requisition comes to his office the buyer immediately notes in the "estimates solicited" column, the names of concerns which he considers satisfactory sources for supplying the material wanted. He dictates a letter to his stenographer to be sent to each of them, or simply hands the blank to her with the names of the concerns selected, and she sends a form letter to each concern requesting a quotation and statement of possible delivery dates.

Copies of these letters are immediately sent to the general


DONESTON MOTOR CO. INVOICE REGISTER

No.	Date	Creditor	Address	Amount	Terms	Discount Day	Date Received	Date Passed	REMARKS

Symbol Material Wgt. R. Mod.

Time to produce Operation Wgt. F. Rec.

Name of part Classification

Date	Order	Firm	Quan.	Terms: Reg. Price	Terms: Trade Disc.	Terms: Cash Disc.	F. O. B.	Net Unit Cost	Freight: Carload	Freight: Less carload	Delivery, and so on

QUOTATIONS

Date	Firm	Address	Price: Amount	Price: Per	Terms: Trade Disc.	Terms: Cash Disc.	F. O. B.	Freight: Carload	Freight: Less carload	Net Unit Cost	Delivery

FORMS XIV–XVI: The invoice register is kept in the buying department, and shows the amount and paying date for every bill received. The middle card, with its quantity scale, gives practically a perpetual inventory on each class of material, and the "quotations" card, kept for each article, shows where the purchase may best be made

files, since the requisition contains all necessary information. The requisition itself is filed in the buyer's desk, numerically, pending answers to the letters. Each letter mentions the requisition number and directs that replies make reference to it. As the replies arrive, therefore, it is a simple matter to find the proper requisition and note on it the quotations and delivery dates promised. When, in due time, all propositions are received and noted, the buyer or committee selects the one which, every-

thing considered, is most favorable. Under the "orders placed" heading, the name of this firm is entered together with the quantity to be purchased and the price. The buyer hands the blank again to his stenographer, who sends the purchase order accordingly.

All purchase orders bear the requisition number, so that there is a ready cross-reference between requisitions and orders. The requisition is permanently filed under its serial number.

The original copy of the purchase order, as sent to the supplier, is shown as Form XI. The arrangement of this copy is convenient, because it groups matters which are similar in character. It is particularly desirable to keep all "price and terms" data separate from the rest of the composition. By having it in the position shown, such information, which it is held desirable to withhold from various individuals outside of the purchasing department, is excluded from copies issued to other departments by the simple expedient of having such copies shortened so as not to receive the carbon impression. One copy of this purchase order is immediately and permanently filed under its serial number. Another copy is filed under the name of the supply house.

On the reverse side of the copy of the purchase order (Form XII), columns are so arranged that all facts concerning the order may be chronicled compactly. If the information is carefully recorded, the form is a desk cleaner and a positive check on all activities in connection with each purchase.

One of the valuable features of this form is the record of shipments. Details regarding shipments are posted as soon as the goods appear, so that the record is kept constantly up to date. Invoices also are recorded as soon as they are received, and are then checked with receipts of goods. When the material arrives before the invoice, record is made to check with the latter. The card thus affords ready information about the condition of shipments, total received to date, amount on the way, and particularly it permits quick attention to discrepancies which come up in checking invoices with receipts.

Invoices recorded but not checked with receipts are carefully placed in alphabetical order in the buyer's file, pending the receipt of the material itself. When such deliveries are finally

made, the correct invoice is speedily found by referring to invoices posted on the purchase order. There the register number of the invoice identifying the receipt is given.

In some cases material is purchased from one source and directed to be shipped to another, to the purchaser's account. These shipments are recorded in the same manner as those made to the purchaser direct. The invoices are received in the same manner, but in order to keep informed of receipts of material at the branch houses a special report form is provided, made out in triplicate and serially numbered. The first and second copies are sent to the consignee, and the third copy is retained by the buyer.

A glance at the form shows that the purchaser has received notice, by invoice, from the supply house, and it reports in full the contents of the invoice. The consignee immediately upon receipt of the shipment reported, notes his actual receipts on the duplicate copy sent him, and returns this duplicate to the purchaser. The purchasing department then destroys the triplicate copy and records the report on the purchase order, thus keeping a close tab on indirect shipments.

Completely filled out for the individual purchase, Form XII is filed away carefully. Frequent reference is made to these records when occasion again arises to purchase the same material.

HOW TO CHECK INVOICES AND RECEIPTS IN THE PURCHASING DEPARTMENT

CHECKING of invoices and receipts in many concerns is performed in the accounting department. This is often unwise, because the purchasing department, having made the purchase and carried on all correspondence in connection with it, is in the best position to identify receipts of material with invoices. Furthermore, the purchasing department needs some record, and by doing the work itself prevents a duplication of tasks. When the invoice, therefore, leaves the purchasing department, it is entirely checked for price, terms, material and quantity, and is approved for payment. Nothing remains for the accounting department but to audit and pay the bill. This puts all work where it belongs.

When goods are actually being received, it is essential that the

No Charges Allowed for Packing or Cartage

American
Electric Specialty Company
99—101 West Grant Street
Chicago

Put Order Number
463
On All Bills and Packages

Clarence A. Anderson,
Buffalo, N. Y.

Date Sept. 27th, 1913

4000 #256 Lamp Sockets on the following Schedule:
1000 Nov. 1st
1000 Dec. 1st
1000 Jan. 1st, 1914
1000 Feb. 1st, 1914.

Specialty Company

FORMS XVII and XVIII: Many manufacturers with small shops cannot afford the expense of a stock clerk. Compact purchasing records widely applicable in such establishments are here shown. By these two forms the purchasing agent is able to order material and record the complete performance

receiving report give all information in connection with the shipment, including the purchase order number. This is done conveniently by Form XIII. If there is no purchase order covering the receipt of any shipment it is simply not received at all. By following this rule, the company has compelled its suppliers to indicate on a packing slip, or on the outside of the container, the purchase order number upon which the shipment is made.

Invoices, for the reasons explained above, come direct to the purchasing departments from the mail-opening room. Form XIV illustrates the type of invoice register in use. Each invoice, as soon as it is received, is recorded and given a register number. By this means it is possible to keep track of the invoice so as to lose no discounts. Further, by recording the amounts of the invoices, the purchasing department knows at all times just how much money its purchases amount to for the week, month, or year.

The record card used to keep track of this kind of material is shown as Form XV. Since much of the business of this concern consists of goods manufactured and sold from stock, large quantities of the same kinds of material have to be bought over and over to keep the supply up to date. The card is self-explanatory, except for the series of figures at the top. This arrangement is designed for use with sliding metal clips. Fastened over any of

Item or Lot No.	Received		Invoice		Remarks	Order Number
	Quantity	Date	Quantity	Date		
527	1000	10/27	1000	11/1		463
	1000	11/27	1000	12/1		
	1000	12/27	800	1/1	200 No Charge	
	1000	1/27	1000	2/1	100 rec'd were defective	
			200		See above	Quality O. K. ✓
	4000		4000			Quantity O. K. ✓

Sept. 27th, 1913

Clarence A. Anderson,
Buffalo, N. Y.

4000 #256 Lamp Sockets on the following Schedule:
1000 Nov. 1st
1000 Dec. 1st
1000 Jan. 1st, 1914
1000 Feb. 1st, 1914

of the shipper, although no stock clerk is employed. The carbon copy above provides space for noting in all essential detail the receipt of material and invoices, and the results of inspection, both as to quality and quantity. Spaces for check marks help to insure their use

the figures, a clip indicates that enough material has been purchased to produce that many units of the article in multiples of 10, 100 or 1,000.

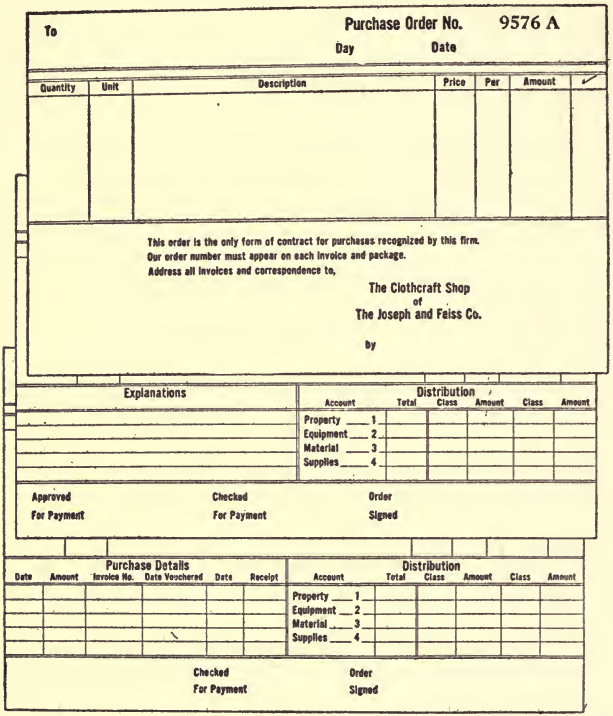
Frequently, certain goods are wanted in a hurry and there is no time to write for quotations. On all such goods a record of quotations (Form XVI) is maintained. With this card carefully kept up to date, one for every kind of material, it is possible to buy satisfactorily with little delay.

A catalog file with an adequate index is also kept. To avoid the difficulty of reference frequently experienced with a large catalog file, the index is made extremely thorough. A five-by-three-inch card is used, and every catalog is indexed twice: first by name of the article or articles sold, and next by name of the maker. It is thus possible to locate quickly for any article all the manufacturers whose catalogs are on hand; or to find from the file what kind of material any manufacturer can supply.

A different method for recording purchases is used by the purchasing agent of a company doing a business scarcely large enough to warrant the employment of a stock clerk. The scheme involves the making of a carbon copy of the purchase order as illustrated in Forms XVII and XVIII.

Many orders are received complete in one shipment, but where

they are not, ample space is provided for the notation of each shipment. Should the order call for more than one number from the company it is addressed to, a separate copy of this form is used for each item. A column for remarks is provided



To

Purchase Order No. 9576 A

Day Date

Quantity	Unit	Description	Price	Per	Amount	✓

This order is the only form of contract for purchases recognized by this firm.
Our order number must appear on each invoice and package.
Address all invoices and correspondence to,

The Clothcraft Shop
of
The Joseph and Feiss Co.

by

Explanations

Distribution

Account	Total	Class	Amount	Class	Amount
Property 1					
Equipment 2					
Material 3					
Supplies 4					

Approved For Payment — Checked For Payment — Order Signed

Purchase Details

Date	Amount	Invoice No.	Date Vouchered	Date	Receipt

Distribution

Account	Total	Class	Amount	Class	Amount
Property 1					
Equipment 2					
Material 3					
Supplies 4					

Checked For Payment — Order Signed

FORMS XIX–XXI: Purchase orders used by the Joseph and Feiss Company are alike except on the lower part, where, on the duplicate and triplicate, the purchase is analyzed. The former is the numerical follow-up, and also vouchers the invoice. The latter is the alphabetical follow-up, and after the invoice has been checked for payment is filed permanently in the purchasing department

so that notations may be placed opposite the particular items involved in any of the adjoining columns.

A record of this kind is of great importance to the purchasing

agent of any company because in it is given the complete performance of the shipper of the goods ordered. It prevents the passing of duplicate invoices from the shipper. Furthermore it reminds the purchasing agent of the necessity of writing to ascertain the reason for delays that show up. Thus it anticipates further delay in time to prevent serious shortages and allow telegraphic requests to hurry needed shipments. Finally it may be preserved as a record and consulted at some future date to determine the length of time required to get the goods from regular sources.

Uniformity in the size of purchase forms has many advantages. In some purchasing departments the purchase order is one size, the quotation price record another, the requisition to purchase still different. This means a variety of filing drawers. Also, when purchase order, requisition and receipt—which must be matched with the invoice and together sent to the accounting department for payment of the account—vary in shape and size, inconvenience is occasioned all along the line. The purchasing forms in use in the Clothcraft Shop of Joseph & Feiss have a special significance in this connection. The 5x8 size is adhered to rigorously. The purchasing order is in triplicate, the original (Form XIX) being on gray crash linen to conform with the regular letterhead. The duplicate (Form XX) is on straw-colored bond and differs from the original only below the ordering information, where, on the first copy the firm name, address and crest and the instructions standard to all purchases appear, the duplicate allows several lines for any detailed explanation, a block of columns for the distribution of the purchase according to accounts and classes of material, and spaces for the approvals of the purchasing superintendent and the auditor. This second copy is known as the "Purchase Voucher."

The triplicate (Form XXI) is a buff card and is called the "Purchase Record." It, too, differs from the original on the lower part. It is identical with the duplicate except that where space for explanation appears on the latter, here columns are provided for the detailed analysis of the purchase—date of purchase, amount, invoice numbers, dates vouchered and dates and quantities received. Of course, if the purchase is entirely fulfilled in one shipment, there will be only one line of entries.

Space for the initials of the auditor—"Checked for Payment"—also appear on the record card, and at the lower right-hand corner of all copies, a place for the signature of the official who authorizes all purchases.

The duplicate and triplicate copies of the purchase order go to the auditor, clipped together with the voucher of the seller, after they have been compared and approved for payment by the purchasing superintendent. The auditor retains all but the triplicate, which, after signing his initials, he returns to the purchasing department. Here it is placed on file and when cross-referenced, constitutes a valuable part of the working information for future negotiations. All purchase orders originate with an E. M. & S. (Equipment, Materials and Supplies) department. Requisition from the department for which the goods are needed, after the E. M. & S. Department has passed the requisition as not covered by stock on hand. This form, also, is 5x8, and is printed on a canary bond. This system contains elements that are worthy the careful study of any purchasing department.

Part II

SETTING UP MATERIAL STANDARDS

AUTHORITIES AND SOURCES

FOR PART II

Chapter IX. Contributed by Mr. Feiker, with J. V. Hunter, mechanical engineer, Mr. Murphy and Mr. Porter collaborating. Among the factories from which the instances are taken are the Garford Automobile Company, a brass foundry, and a manufactory of toilet articles.

Chapter X. Contributed by Mr. Feiker and Mr. Rockwell in collaboration with H. S. Hosford, engineer of methods, Western Electric Company; Philip E. Kuntz, purchasing agent, Felt & Tarrant Manufacturing Company; Henry D. Martin, formerly general superintendent, I. E. Palmer Company; Mr. Murphy, and Mr. Porter. The investigation extended into more than a score of different lines. Particular mention is made of the experience of wood-working plants, a vehicle factory, an automobile company, a hammock manufactory, an office-appliance concern, and three electrical manufacturers.

Chapter XI. H. Cole Estep, Penton Publishing Company; and Mr. Porter, in collaboration with Mr. Murphy, contributed this chapter. Among the lines mentioned are leather, metal, telephones, petroleum, paint, and electrical specialties.

Chapter XII. Contributed by Frederic Dannerth, consulting chemist, and Mr. Porter. This chapter includes material supplied by H. A. Russell, of the purchasing department, A. B. Farquhar Company, and also the rules for drawing specifications laid down by Dr. Charles Benjamin Dudley while president of the International Association for Testing Material, and the American Society for Testing Materials.

IX

ELIMINATING GUESSWORK IN BUYING

COMPLAINTS from dealers about the quality of the product several years ago poured in upon one of America's best known firms manufacturing toilet articles. Its various brands of perfume had in one season lost their lasting qualities. Some were without fragrance after only a week or two. The concern's reputation and good will were in peril.

The head of the department was nonplussed. He made perfumes as his father and grandfather had made them before him. He could detect no deterioration in his methods.

So the president had to seek advice outside the plant. Breaking the rule of years as to secrecy of manufacture, he called together his heads of departments, introduced the assistant in chemistry he had obtained from a neighboring college, and gave him the privilege of investigating without restriction.

Then ensued an interesting trial between the rule of thumb and chemistry. After three days of friendly visiting with the head of the perfume department, the young assistant, now a well-known consulting chemical engineer, was finally allowed to enter the laboratory on pledge of absolute secrecy. And the whole trouble was located in that first walk through the department. The raw material, alcohol, was not up to grade. It contained fusel oil, which was responsible for the failure of the product.

In the readjustment which followed, the president proved that he had learned a lesson regarding guesswork in purchasing. He established a laboratory and set chemists to work standardizing materials and processes. When later the department head died, and the traditional methods seemed about to be lost, the formulas

and specifications were there to take their place. And from that time production in this plant has rested on not guesswork, but on laboratory methods. Material requirements are ascertained and standardized. These standards become specifications and are included in the contract. And by these standards, the purchasing agent sees to it that the supplier lives up to his bargain.

Rules of thumb served well enough when production was measured on a one-man scale, buying in household quantities. In those days the proprietor, doing his own buying, inspection and handiwork, could regard his first order merely as an experiment, and by skilled personal inspection could soon make certain that what he bought was what he needed. But in present-day production for national markets, with narrow border lines of profit and with world-wide sources of supply to draw upon, purchases by tons, representing fortunes in invested finances, must not be founded on guesswork. And fortunately, scientific knowledge of materials has kept pace with this need. The purchasing agent no longer needs to guess; he can make almost every important purchase conform to specifications and pass the searching microscopic eye for quality (Forms XXII and XXIII).

Buying is, in fact, fundamentally a campaign against guesswork. The factory is rarely positive as to either the sort, quantity or quality exactly suited to its needs. Under conditions of modern transportation, possible sources of supply may number thousands, affording a bewildering gradation of advantages for the purchasing agent to select from. Similarly, the trend of general supply and demand as affecting prices and deliveries, presents a factor so complex that guesswork can only be minimized. And even after the purchasing agent has determined these matters, nothing short of the most exact specifications can express his wishes in so precise a way that the supplier cannot misunderstand them. Moreover, the latter may still blunder, may be misunderstood by *his* supplier, may allow too wide a variation in his standards of workmanship, may be tempted to substitute or slight or adulterate. Only exact specifications and tests will then enable the purchaser to "nail" the error and force an adjustment. And with guesswork on any of these points, the purchasing agent is more or less uncertain regarding the

Tomorrow's purchasing depends upon today's records. Two handy pieces of special equipment for buyers are here shown. Above is a sorting desk at the Baker-Vawter Company in which requisitions or orders are quickly sorted for totaling on an adding machine for accounting purposes. Below is a wheeled filing tray on which the stock records stand, for ready reference and easy storage in the vault

The modern factory has not only gone to the outside laboratory for help in selecting materials, but has also found it worth while to install specialized laboratories and to devise ingenious testing equipment of various types. In this laboratory oil is undergoing tests for density, flash-point, viscosity, and lubrication value

price he should pay—open to the blunder of too low first cost, or of paying high prices for reputation only.

Equipped, on the other hand, with full knowledge—of sources of supply and market conditions, of the demand made upon him by his factory, of the elements and processes involved in supplying what he requires and their cost—the purchasing agent is in

TENSILE TEST

PIECE NO. 5720 - 3-4 CARD NO. 4
P. O. NO. 12200 DATE Nov. 4. '14 TEST NO. 6
DATE RECEIVED 8-31 '14

MATERIAL O.H. Steel
CONDITION OF MATERIAL cold rolled
MANUFACTURED BY Union Drawn Steel Co.
SHAPE O LENGTH BETWEEN MARKS 2"
BREADTH THICKNESS DIAMETER .5624

ORIG. AREA .25 sq. in. STRESS AT RUPTURE 86,000 lbs sq. in.
CONT. AREA .1764 sq. in. STRESS AT EL. LIMIT 51,200 " " "
% CONTRACTION 49.44 % ELONGATION 2.53" = 26.5%
CHARACTER OF FRACTURE

THE GARFORD COMPANY

FORM XXII: On this form the chemist of the Garford Automobile Company keeps a record of the physical tests of bar steel and similar materials. From every shipment a test piece is taken. This is placed in a testing machine and the tensile strength recorded. A chemical analysis is also made from chips of the same steel

a position of natural advantage. He then knows what to get, how to get it, what he should pay for it, whether to buy a stock item or have a composition made to his order, and finally, whether he is getting what he purchased.

BUYING BY DEFINITE QUALITY KNOWLEDGE BASED ON DEFINITE METHODS

PURCHASING has not yet grown up to the problems brought upon it by the sudden and enormous expansion of modern supply and demand. Advertising has done something to bring the groping buyers and sellers together, but many purchasing agents have not yet learned how to comb the markets for what they want. Recently the purchasing department of a large

corporation was unable to meet the specification to finish the telephone instruments in a hotel in a mahogany enamel to match the furniture. After the plan of decoration had been changed, however, a small manufacturer located in the same city turned up with exactly the finish needed. Buying right has come to mean buying with definite knowledge, worked out by definite methods. This case is an illustration that such knowledge and methods are needed even in the location of supply sources.

It is in questions of kind, quantity and quality, however, that the methods of precision have made the most headway against guesswork in buying. The origin of specifications usually lies in the fact that some difficulty has arisen in a process; some machine ceases to give satisfactory service; some structure fails; some material in use does not give good results. This difficulty results in an attempt to locate the cause. In other cases a largely used product, furnished by different makers, is found to vary in quality. Sometimes it is desired to standardize certain practices, and make them uniform in all the mills of the corporation, and to do so requires that the same quality of material be furnished and used in all cases. This development leads finally to the issuance of specifications.

A fourfold advantage usually follows. The testing of samples and the working out of specifications, either in the factory or with technical aid, in the first place, lead the purchasing agent and the production men to determine their needs exactly. Often the factory heads have had only a vague idea of what they want. To get a sharply focused idea of the need eliminates guesswork and is the first rule of sound purchasing. In the purchase of several carloads of catalog paper, this advantage was recently called to the attention of a factory executive in an unusual way.

Instructions to the advertising man had been to make proper selection of paper and in cooperation with the purchasing agent to obtain bids from different paper houses by circular letter. In so doing he sent the form letter also to an industrial chemist, who, he had heard, was a paper expert. The very first reply was from the chemist. And instead of merely asking that he be consulted in the placing of the contract, he had criticised the purchaser's crude description of what he wanted.

The publicity head had considered appearance, strength,

weight, price and the fact that halftones, line drawings and type would in many cases appear on the same page. To the specification of weight the chemist added bulk; to appearance, color; to strength, durability and the service treatment demanded for the maximum number of halftone screen lines to the square inch. Finally, he suggested that the quantity contemplated would warrant a "mill run" and thus afford a paper especially adapted to the purpose in view.

In the second place, exact knowledge of what is needed enables the supplier to get a clearly defined idea of what he is expected

TEST RESULTS OF MATERIALS OR SUPPLIES

Article Primer - Pink — Date rec'd 6/9/14

Size — Price 5¢ lb. Del. — Use Priming woodwork

Mfrd. by Eureka Paint & Oil Company — Brand "Best"

Sold by " " " " — Tested 7/8 191 4

Our Present Standard "Extra" - S.V. & O. Co. — Price 5¢ lb. Del.

Method of Conducting Test Actual use

Results It does not brush out as good and it does not cover as well as our present primmy

Tested by E. E.

FORM XXIII: When verbal reports on material tests were found insufficient in one factory and led to disputes later on, this report form was planned. The record covers a test made of a new paint tried out for priming

to furnish. Scientific standards allow neither that the buyer guess what the shop wants, nor that the seller guess what the buyer wants. Chemical research among metals, for instance, has resulted in specifications that define steel and alloy requirements more clearly than the average purchasing agent could possibly do in any other way.

Such specifications, to mention the third advantage, not only focus the factory's requirements and furnish a standard to which the supplier can work; they also equip the inspectors with

tests and measures by which they judge deliveries, in search of adulteration, substitution and other errors. This, again, is a fundamental rule of sound buying. With many commodities, adulteration or substitution is difficult of detection, and therefore so tempting that specifications have been the buyer's natural recourse. Lard oil for screw-cutting machines, for instance, can be obtained in what is termed a "mineralized" state or with a certain per cent of mineral oil added to cheapen the cost. When pure lard oil has been ordered, do you guess or do you know that you are not receiving the cheaper "mineralized" product? Of the cases investigated by one purchasing agent, nearly fifty per cent have shown adulteration with either mineral or cottonseed oil. The latter adulteration is a particularly hard one to detect.

Turpentine, too, is often adulterated with a percentage of mineral oil, usually a heavy naphtha, which will lengthen the drying period. Casual inspection will rarely protect the buyer against such conditions.

SPECIFYING THE CHEAPER PRODUCT AND PAYING ONLY FOR IT

ANOTHER case of adulteration indicates the necessity of something more than guesswork in the purchase of special alloys. An Ohio Valley firm was furnishing some five per cent phosphor-tin alloy to a brass foundry. This alloy was used in various valve castings of great weight. When several successive castings had been lost, samples of all the raw constituents of the alloy were rushed to a chemist, who found in the phosphor-tin seventeen and nine-tenths per cent lead. Pure phosphor-tin was then worth forty-eight cents a pound, while lead was worth four and one-half cents. Yet the supplier explained that he "considered that the addition of the lead would in no wise injure the metal when used in bearings." Specifications based upon and checked against tests now relieve this concern of the danger of buying lead at phosphor-tin prices.

If for the service rendered, an adulteration does no harm, to eliminate guesswork enables the purchasing agent to specify the cheaper product and pay only for it. And if the adultera-

tion is hurtful, it is better forbidden in the contract and detected by receiving room tests than left to guesswork and discovered running through the finished product. When it comes to adulterating what is purchased, the average manufacturer will prefer that his own experts, rather than those of his suppliers, plan the adulteration and award the saving.

Finally, specifications and knowledge of basic elements furnish the purchasing agent with a key to prices. They put him at an advantage in considering bids, in bargaining, in arranging adjustments. By means of them, mixing to formula on a cost-plus basis has become a business, and by resort to this plan many purchasing agents obtain exactly what they want at the lowest price consistent with value. In the purchase of bronze alloys, for example, a manufacturer by this method consistently saves several cents a pound.

In many plants, it is the work of one engineer or department to find what each item purchased "ought to cost," by study of materials, processes and correct cost-keeping. Whenever time permits, such analysis is the purchasing agent's one masterful approach to his problem. It is only when an emergency or a blunder forces the buyer into the market without cost data that he is open to the perils of secret price manipulation.

SPECIFICATIONS PUT RESPONSIBILITY ON THE LABORATORY AND LEAVE THE BUYER FREE TO STUDY MARKETS

BUT specifications by no means reduce purchasing to a clerk's job. The policy of buying by specification throws more rather than less responsibility upon the purchaser, for it assumes that those who set and maintain the standards *know*. The burden of judgment as to kind and quality is merely shifted from buyer and seller to the laboratory specialists, and the purchasing agent who is sure of his backing is thus left free to study markets and campaign for values.

The buyer who purchases on the strength of his supplier's reputation will sometimes run less chance of making errors and is always more certain of having these errors corrected for him than when he buys by specification regardless of reputation. For this reduction of risk, however, he pays the premium the

supplier must charge to cover the insurance for which his reputation stands.

Purchase from favorably known firms does not mean buying by guesswork, but it does mean buying on faith. In emergencies, or for those supplies and materials which specifications and tests fail to cover, it is as a rule the best method. So the wise manufacturer when in doubt buys the well-known brand thoroughly backed with reputation, but the wisest manufacturer seeks economy by having specialists draw up specifications as largely as possible for all materials and lay down tests by which, when received, it can be determined if purchases conform. As the manufacturer in this way matches his true requirements against the market with precision, he determines scientifically and perhaps once for all, that balance which assures a product of the lowest cost with the highest quality and the best service he can give his customers. Thus he equips his purchasing agent with an exact knowledge of what is required, and so places him that he can safely contract for it. If in addition he makes it the definite duty of someone to keep all specifications up with changing needs and changing markets, guesswork on the purchasing end is eliminated perhaps as far as is humanly possible.

How materials are being tested and standardized by craftsman tricks and "kitchen" laboratory methods in the small shop and in the large plant through its costly laboratories, research departments, high-salaried specialists and exact specifications, is told in the following three chapters.

X

PROVING MATERIALS IN THE FACTORY

RECALLING boyhood memories, a city man recently visited the little woodworking plant where as a youngster he had nailed cases. While he was waiting to meet the son of his former employer, he saw one of the workmen open a dry kiln and draw out a board from the center of the pile on one of the bunks.

But the expected did not happen. The workman did not smell the board to see if it was dry. Instead he took it to the nearby saw room, sawed it in two and cut out a little section from the center of the board, marking on the chip the number of the bunk.

The city man was curious. This wasn't the way they used to test lumber, so he followed the workman to the superintendent's office, wondering what he was going to do with that little piece of wood.

Taking the bit of board, the superintendent weighed it in a pair of apothecary scales and told the man to put it in the steam chest, first marking the weight on a slip of paper and hanging it on a numbered hook. After being thoroughly dried over the steam radiator or in the steam chest, so the former shipping boy learned, the block would be weighed again. If it lost six per cent of its weight it was not yet sufficiently seasoned to be made into desks.

The visitor, out of touch with improved methods, had happened upon an instance of the rough and ready application of science which makes every up-to-date factory somewhat of a laboratory in its study of materials. Especially in the small plant, where

it is not feasible to maintain special installations for testing purposes or to retain the services of industrial specialists, the manufacturer is striking a sound compromise between science and rule of thumb, by which he gets most of the advantages of the former at a first cost not much greater than that of guesswork. The "hundred thousand dollar hill" by which a great automobile plant simulates costly road tests may be out of the question for your shop, but you can still make many homely applications of the same scientific principles in your study of materials to be bought. Microscope and micrometer, test tube and acid no longer need mystify the manufacturer. It is often a simple matter to analyze and know, as did the superintendent of the woodworking plant, instead of merely guessing.

First challenging the way the buying "always has been done," manufacturer and purchasing agent accumulate all such quick and inexpensive tests they can learn. Salesmen, other buyers, outside specialists and the literature covering the field afford them many such suggestions. Closely watching materials throughout the processing is always instructive as to standards and short cuts. Whatever else is done or omitted, however, the wise manufacturer will allow no important material to go into the shop routine without first submitting it to a "service test." This is simply a reproduction of service conditions, by which you can determine with finality whether or not a material stands up or how the various materials available compare in endurance.

Service tests are often of the simplest and least expensive. Yankee ingenuity at once suggests water as a test for certain belts, gloves, cement or paint. For almost every material, similar proof can be devised. Regard for this single principle of making a sample undergo a skillful imitation of the service the material must withstand will usually enable the purchasing agent to crowd guesswork almost out of the reckoning. Whether or not laboratory procedure also will be worth while depends on the conditions.

Laboratory tests, moreover, are by no means an infallible guide. A stove foundry several years ago inaugurated the policy of blacking all cast-iron stoves. Brand after brand of blacking was tried, but for some reason, none of them seemed to stick. Finally, a specialist was brought in. Schooled in the scientific approach,

he did not accept as final the conclusion that because a brand of blacking failed to stick, the blacking itself was at fault. The high speed at which the buffing wheel was running challenged his attention, and he began to experiment with different speeds. From fourteen hundred revolutions per minute he slowed down the wheel finally to six hundred revolutions per minute, at which speed the blacking took hold perfectly. Here was a case where the most refined laboratory test would have been of little avail. The conditions of use were the determining factor, and really the only accurate gage of the quality of different brands was the speed at which they could be applied. Some would work with higher speeds than others. The one which made the best showing, appearance and other things being equal, was finally settled on as standard.

Cotton-cloth manufacture furnishes another example of the value of service tests in the factory. A cotton passed by a laboratory as superior might not work up with the least waste or give the best results in general. A poorer appearing cotton frequently proves up better in the end. A mill was operating successfully with a cotton on which the percentage of waste seemed a bit too high. The material was slightly off-color, but it worked up well and production ran smoothly. Finally, a new lot of cotton was brought to the superintendent's attention. He was given the choice of using this or sticking to the old grade. As the new kind was white and apparently free from foreign matter, and in general had a superior appearance, the superintendent was not slow in making his choice. But it proved to be a bad cotton to run. It had little strength, it spun with difficulty, and the waste exceeded that on the old grade. Had a few bales been purchased and put through service tests, this mill would have saved itself much trouble and money. A form employed by one cotton mill to record the results of tests for preventage of waste is shown (Form XXIV). One or more bales of each of the different brands submitted are put through the mill and careful account is kept of the waste at each stage. With these results before him and a knowledge of how the material worked up, the superintendent can select his brand with almost scientific assurance.

So it is with many of the materials and supplies used in man-

ufacturing. Carefully supervised service tests in the factory, under actual working conditions, not only may be the simpler and less expensive, but may furnish a proof not possible in the laboratory, except at the cost—often great—of duplicating actual conditions. Laboratory tests, however, are frequently of value in addition.

A vehicle factory in buying glue, for instance, first makes the glue do actual service in the shop. Sample pieces of wood are glued together with the different glues and tried for strength, sweetness and appearance. With the glues which lead in these tests, laboratory experiments are made by a glue specialist as a check on the factory tests. Samples of glue marked with key numbers are sent to him and he compares his findings with the shop results. The cost of the shop tests is insignificant compared with the sum paid under the yearly glue contract. The laboratory work is simplified and the product is doubly safeguarded.

COMPARATIVE SERVICE TESTS REVEAL AND ASSURE THE DESIRED QUALITY

AS proper treatment in the manufacture of some materials means almost as much in the finished product as the composition, comparative service and exposure tests, rather than chemical analysis, are often of the first importance if the purchaser is to be assured the best value. The service test may be a check on both the chemistry and the physics of the material. A New York furniture manufacturer places a high value on such a plan. Never absolutely sure of his varnish, he could not guarantee it to be weatherproof in every instance. One day he went through an implement plant in the Middle West. When he returned home, he took with him the solution of his difficulty —a "liftable" test for weatherproof varnish.

The test is simple. Take a dry wooden panel of any convenient size, apply the varnish, allow it to dry, lay a wet sponge on it and inspect from time to time. Cheap varnishes containing rosin in large proportions will soon be effaced. Durable and weatherproof varnishes will not be affected seriously for hours. If the test is begun in the evening and the varnish is destroyed by the following morning, a new test with frequent inspections is made. But if no serious effect is noticeable, the tests are

continued until the weatherproof qualities of the different samples appear decisively. In such tests, a material of known quality is usually included to furnish a standard for comparison.

With this test as a guide, the furniture manufacturer now revises his varnish standards constantly. When a varnish contract is to be let, he writes to several houses for samples. As these are submitted, he tests them in comparison with the standard varnishes of past years. Not infrequently he betters his purchase not only in quality but also in price. And as each varnish becomes the standard, it also faces similar competition the coming year.

WASTE TEST

Mill No. 3 Date 12/15/14

Cotton Grade Middling 1" Staple

KIND OF WASTE	POUNDS	RECLAIMED WASTE FROM FIRST RUN	FIRST DROPPINGS	RECLAIMED WASTE FROM DROPPINGS	SECOND DROPPINGS	TOTAL TIME RUN MINUTES	DUST OR INVISIBLE WASTE	TOTAL WASTE RECLAIMED	PER CENT OF SHRINKAGE
CARD. FLY	100	84	15	2¼	1¼	1¼	1¼	86¼	13.75%
CYLINDER STRIPS	100	93	6¼	1¼	4¼	13¼	1	94¼	5.50
DOFFER STRIPS	100	92	7	1	5	14	2	93	7
NO. 1 PICKER	100	40	57	2	53	13¼	5	42	58
NO. 2 PICKER	100	39	60¼	8	50	16	5	45	55

FORM XXIV: By putting several bales of cotton through the mill at different times and keeping track of the waste made during every process, averages were found for the various tests. As a result, standards of waste for the different departments were obtained

Not only does the service test enable a manufacturer to improve his material from one contract to the next, but it also enables him to measure the value of new and unfamiliar materials in comparison with materials which have become standard. When important new sources of supply open, specifications often must be altered or abandoned. The service test indicates to the purchasing agent whether or not the new material merits consideration. Frequently these shop tests draw distinctions which even the laboratory fails to catch.

A few years ago the first principle in the purchase of oil was

"buy to specification." Anti-friction specialists were well agreed that the quality and bearing value of oils could be determined accurately by their gravity, flash, fire, cold and viscosity tests. But as new crudes with different chemical and physical properties have come on the market, buying to specification is admitted to be less dependable as a guide to oil values. While the old tests draw true comparisons among oils produced from the same crude petroleum, they are not final as standards for oils refined from different crudes, as the Pennsylvania or paraffin-base oils, in competition with oils from the western and southwestern crudes which have recently appeared. The latter are being marketed on the basis of shop results; the former still on specifications. So the purchase of lubricants is an instance where the dependable policy is to make sure of actual service before buying. Each plant more or less presents an individual oil and lubrication problem.

Sometimes shop tests are the sole means for insuring quality. Among the supplies for which a manufacturer of electrical goods has found it impracticable to write specifications are various abrasive papers and cloths. After an investigation, shop tests were established as a means of choosing among four well-known makes.

Even where exact and successful specifications exist, they will usually include shop tests which assist the inspectors in checking on deliveries. The more exacting are the quality standards of the shop, the more extensive must these service tests be. In automobile manufacture, for example, the strength and quality of the materials must be known to a certainty, for a weak part may mean a serious accident.

A group of testing machines at the Ford plant appears on page 109. Here tension, compression, torsion, hardness, in fact all the strength qualities of materials, are studied and measured. After formulas have specified what composition should supply these qualities in the desired degrees, experiments judge whether the qualities have actually been developed. In the foreground of the photograph an automobile front axle is shown under a torsion test which is designed to reproduce and exaggerate actual road conditions.

How a manufacturer can obtain laboratory results in testing

materials with simple and also inexpensive equipment is well illustrated by the precautions which the manufacturers of a high grade computing mechanism take in making sure of the quality of the material purchased. Standards for cold rolled steel, for example, are maintained by the following tests:

1. The surface of the steel is examined under a magnifying glass for pits and scale, and the edges for seams.
2. The micrometer is applied to determine the thickness.
3. Density and grain are ascertained by cutting off a small piece, bending it back upon itself, beating the bent edge with a hammer, working the steel back and forth until it breaks and finally examining the broken edges with a glass.
4. To test the hardness a small piece of flat steel is hammered upon the anvil of a scleroscope.
5. Blanks are punched in a die and the cut edges examined for color, grain, seams and density.
6. As a final test, the steel is given a sharp right bend, after which the workman examines it with a powerful glass.

No manufacturer can excuse continued guesswork in the selection of materials, in the wording of the purchase contract, or in the inspection of incoming stores, when tests as simple and as helpful as these can be applied to almost every material he buys in quantity. His own ingenuity, if called into play and spurred by what other plants are doing, will suggest how a material can be made, as one superintendent said, "to live a year in a day." As he is warranted in standardizing still further, the manufacturer will naturally seek the advice of industrial laboratories and perhaps install certain scientific testing processes in his own plant. How most large corporations now maintain their standards for all important materials and processes (Frontispiece, and Pages 92, 109, 110, 127 and 128) is well illustrated by the practice of the Western Electric Company.

Any piece of apparatus that fails in the slightest particular to reach the specified standards, the inspection and engineering departments of the company will not accept from the manufacturing branch. The manufacturing branch, therefore, must protect itself by tests which indicate the quality of all raw materials with precision. The magnet of a telephone receiver

capable of catching the feeble impulses from a voice three thousand miles away, and reconstructing them into faultless speech must not merely be a good magnet—it must be a practically perfect magnet. Expert workmanship must be expended upon absolutely first grade materials. The factory, therefore, subjects its magnet steel to rigid tests. Samples from every shipment are first analyzed by the company's chemists and if the composition is found to differ from the close requirements of the specifications, the shipment is rejected. If this test is safely passed, intensified service tests to which the material is always submitted in the shops may still develop a flaw. If, finally, the rejected magnets reach ten per cent of the total, the shipment of steel goes back to the supplies.

Another company maintains its paint and varnish standards largely by means of the film-testing machine shown on Page 110. This device measures the strength and elasticity of films. The numerals designate parts as follows: (1) counter-balance for iron-rod, (2) switch controlling magnet No. 8, (3) switch controlling magnet No. 4, (4) magnet controlling mercury shut-off, (5) shut-off handle of stop-cock for mercury, (6) cork float fastened to iron rod to indicate the height of mercury, (7) glass graduate burrett for mercury, (8) electro-magnet to hold iron rod when film breaks, (9) brass plates for holding the film, (10) dry cells for furnishing current for electro-magnets when film breaks, and (11) pulley for counter-balance control. The paint and varnish films are stretched between the two brass plates (9) both of which have holes in the center. Mercury is allowed to run into the lower glass tube. When the weight of the mercury breaks the film an electrical contact is established, and the flow is instantly stopped. The difference in the readings of the height of the mercury in the tube (7) gives the strength of the film in cubic centimeters of mercury. This strength is then readily computed in ounces or pounds per square unit of surface. Once standards are obtained, samples can quickly be tested.

Wherever ingenuity can intensify service conditions and thus apply a severe service test in a short time, this plan with due care to maintain an unvarying basis for comparison, will prove the materials sufficiently for routine needs.

XI

OUTSIDE HELPS IN SETTING STANDARDS

SHORT cuts in chemistry and service tests of purchases will usually keep materials working smoothly fifty-one weeks in the year. It is not difficult to maintain the inspection routine, once the scientific formula or trade secret is learned, even if the tests involve some laboratory "magic." In the other week, however, because of some change in the routine or some unexplained difference, materials or supplies may cause as much trouble and far more perplexity than a wrench in a machine.

At such times—when standards prove ineffective or new standards are called for—the manufacturer has several important outside resources upon which he can draw for information. First among these resources is the customer, the man who uses the goods into which the material goes. Watching service tests is his daily occupation.

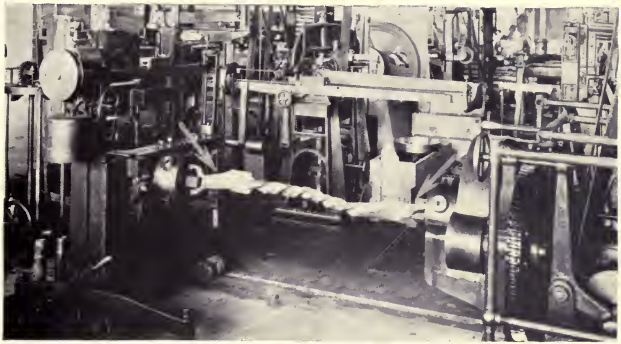
Next is your own sales force—the edge of contact with the customer, and often the means whereby the user's criticism is interpreted and transmitted to the factory. While the judgment of neither can be classed as "scientific," their common-sense analysis of flaws and their causes, if given due consideration, frequently puts the factory on the trail of the real difficulty. Occasionally the exceptional consumer is found, whose special training and knowledge enable him to put his finger on the trouble while even your inspectors are still groping. When stimulated by contact with the trade, moreover, salesmen with technical training and shop experience, sometimes of their own initiative, bring up points in advance of any definite complaint, which are of the utmost value to the factory whose aim is always to be at least one step in the lead.

The laboratory specialist is also available in any large city—and not only does he usually understand the science back of the rule of thumb, but he also has the specialized equipment required for analysis of materials, and is a student of the experience of other manufacturers in similar lines. Finally there are trade and association records and publications to consult. Standards for materials in many factories today represent this combined experience of manufacturers, consumers, salesmen and consulting chemists or engineers.

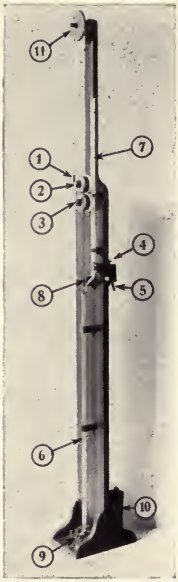
Often the crisis develops in the sales department, and its cause is traced back to the purchasing office only after following out many false leads in the shop. Complaints from Australian consumers drifted back to an American manufacturer with increasing frequency a few months after he had reached out into the foreign market. The gist of the complaint was that the japan used in coating brass tubing was scaling. The manufacturer ordered a thorough investigation. He expected to find that some shipment of japan had not been up to standard.

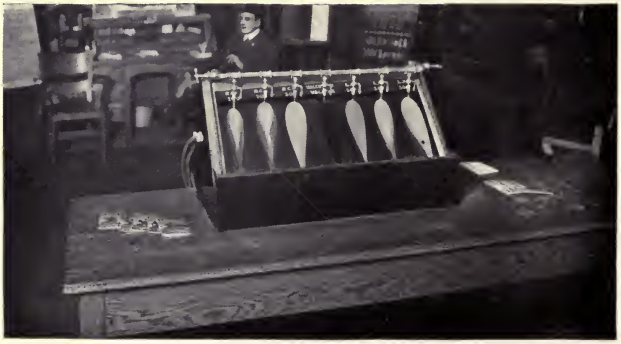
But the report of the investigators showed the difficulty to be due primarily to climatic conditions and suggested that indications of the same trouble but of less severity ought to show in this country. This proved to be true. Having but little competition, the concern had developed its domestic business without any effort to capitalize the experience of consumers in improving the product. Substitution of steel for brass tubing remedied the trouble, as the japan did not easily disintegrate when coated on the former. Since then, the president has insisted also upon a monthly complaint report. Through this analysis of complaints and the solicitation of suggestions from consumers for improving quality, he has been able to make several profitable changes in his product.

Every complaint which is received is recorded upon a special form, and copies are sent to the various officials interested. The manufacturing department compiles these complaints and a comparative chart is placed before the president each month. In this manner he is enabled to keep his finger upon the defects of his product. Because one customer writes a caustic letter regarding his purchase does not necessarily indicate that the design or material is wrong. By means of the comparative



Material testing is here shown. At the top is the laboratory of the S. Obermayer Company. Just below is a group of special testing machines at the Ford plant, showing an automobile front axle undergoing the torsion test. At the bottom is the laboratory of Durand & Kasper, where Dr. Lloyd passes upon foodstuffs which are sold under exact specifications to the United States Government





Intensive service tests quickly determine the lasting qualities of many materials. Below are shown comparative tests of seven brands of varnish, six of which in varying degrees have turned white. At the right above is shown a filmometer, by means of which the strength of the paint film is accurately measured. At the left, a painted sheet of metal has undergone a long time brine test

complaint chart, however, the executive can see at a glance what is causing the most trouble.

A sudden unexplained variation in the action of his material generally sets the wise manufacturer to investigating or consulting a specialist. And the explanation often has a cash value.

What looked to him like an excellent opportunity to improve his product, and thereby fight sudden and dangerous competition, was accidentally discovered by the superintendent of an eastern brickyard. Clay from a new quarry had been used for a batch of bricks, and instead of the standard red they have come out in variegated colors.

To discard both the lot and the clay was the foreman's impulse, but the superintendent possessed an artistic eye and the imagination which can see far-reaching possibilities in an innovation. Instead of condemning the bricks, he ordered them put on the market as fancy building material. The "tapestry" bricks proved at once an effective weapon against the encroachments of cement, which had become a rival of brick for dwelling houses largely because of its decorative possibilities.

The clay, however, proved to be far from constant in quality. The colors of the fancy bricks were not dependable, and architects who had specified a certain shade from samples of the first lot shown, would not accept the off-color ones which in several instances were shipped to them. As a result, the superintendent had a chemist analyze the clay and make various tests to discover what metals or other impurities in it caused the different shades of color. He then had specifications drawn up for the various colored brick, and thereafter mixed his common clay with the materials necessary for any desired shade. To guarantee the color absolutely was the next step.

This is only one of the many problems connected with material standards that are constantly being solved by factory managers in cooperation with industrial chemists. Managers are finding that chemical action may be harnessed, just as other natural forces have been. Nor is it necessary to run a big laboratory under heavy expense, in order to reap the benefits of a proper application of chemical forces. In a case where coal is bought on a basis of thermal units delivered, the manager of the plant

simply saves a small sample from each day's delivery; at the end of the month he has these samples thoroughly mixed and sends a five or ten pound batch to the chemist for analysis and rating.

USING MATERIALS UNSUITED TO EACH OTHER RESULTS FINALLY IN A LOSS OF TRADE

FREQUENTLY the purchasing agent learns that his whole trouble with an item comes from using materials that are chemically unsuited to each other, as in the case of a Chicago tanner. This man had learned his business in England, in a tannery where at that time they used the old-fashioned method of immersing hides in the tanning pits with raw oak bark. But although it insured an excellent grade of leather, he had found this method too slow to enable him to keep pace with his American competitors, and he had been trying various tanning extracts instead. Most of these liquors are made by extracting the tannin from oak or hickory bark and are supposed to do by quick, direct action what the raw bark does much more slowly. The successive stages of tanning, however, require a varying amount of tannin and the Englishman had been unable to adjust the amounts of liquor used so as to get a soft, well finished skin.

"I'll admit it's a quicker process," he said, "but what good does that do me if the leather comes out as hard as a board? Smith [a rival tanner] treats his hides with grape sugar, I understand, and they look all right, but they won't wear; and I will not turn out poor leather. What's more, I haven't been able to get a perfectly dyed skin since I started using this ooze instead of bark."

Could hides be chemically treated so as to give good leather? was the first question. The chemist solved it by insisting on a definite per cent of tannic acid in the ooze, or liquor purchased. This specification involved careful analysis, but at length he found a maker who could be depended upon to "deliver the goods" and give a standard agent to work with. Then by starting the tanning in vats filled with a weak, diluted solution of the liquid, and gradually increasing the proportion in successive pits, the chemist reproduced the process as it takes place in the pits with the raw bark.

Dyeing the hides presented still another problem. Dyes which gave good results with hides tanned with oak bark were uncertain or worse when used in conjunction with the tan liquor. The trouble must therefore lie in the reaction among the chemicals in the dye and those in the tannic acid solution. It developed that a reagent in the liquor and one in the dye were neutralizing each other and thus preventing the action of the dye on the leather. The chemist sought for a solution which would carry the dye and not have an affinity for the tanning liquor. After a little experimenting he found such a solution and ascertained as well, that another make of dyes already on the market showed the same analysis as the solution he had developed. Being thus assured a supply of a standard tanning agent and of dyes that were chemically harmonious with it, the tanner, who was an expert in the handling of leather, had no difficulty in turning out as good leather as with the raw oak bark and his home-made dyes.

HOW MIXING METALS BY RULE OF THUMB HANDICAPPED A FOUNDRY

FALLING in with the present tendency toward standardized, cooperative effort rather than individual expertness, a foundryman sought out a commercial laboratory not long ago. For twenty-five years the metals going into his brass castings had been proportioned by an old melter who had grown gray in his service, and it had never occurred to the foundryman that the younger generation was not receiving such training as would fit one of them to take the old man's place. To his great surprise, after the melter's sudden death, he had found it impossible to replace him with anyone who had adequate experience for the job. At the suggestion of a fellow foundryman he finally came to the chemist for advice, although it was plain that he placed more dependence on the old man's "rule-of-thumb" method—a method based on an intuitive skill developed through years of costly experiment—than on any theoretical knowledge. His confession of his difficulty was made grudgingly and he wound up with:

"But I won't have any high-priced chap fresh from college

fooling around my plant. There isn't enough work in that small foundry to keep him busy, even if I did want him."

Investigation proved that he was right. At the chemist's suggestion, therefore, the manufacturer made a contract with a large foundry, which specialized in brass making, by which he purchased from them certified brass ingots of any desired quality. The proportion of the metals in the brass was guaranteed within one per cent. A laboratory certificate and analysis accompanies every shipment of ingots and assures the purchaser that he is getting just what he specified. The smaller foundry casts the remelted ingots and machines and finishes the castings. In the old days its brass, roughly classed as "red," "yellow" and "white," was at the best rather uncertain in quality. Now the shops have a standardized product, of any grade their customers may have specified for their castings, and that at less expense than in the days when they made their own blend.

Often the manufacturer can further save himself expense and trouble in getting information as to a material by enlisting the aid of various types of organizations.

An example of the cooperative efforts of those concerned in setting material standards is the American Society for Testing Materials. Many of its sub-committees are engaged in the preparation of standard specifications. In the membership of each sub-committee there is representation from manufacturers, consumers and consulting engineers. The resultant specification, therefore, is one that satisfies the man who makes the goods, the man who uses the goods and the designer and adviser. Much information can also be obtained from the published works of such representative bodies as the National Fire Protection Association, the American Chemical Society, and the International Congresses of Applied Chemistry.

Standard specifications are drawn up and revised from time to time by the Association of American Steel Manufacturers. These specifications include and define methods of manufacture, tests, and inspection, in addition to the common provisions for insuring quality. They are complete for structural and sheet metal and various miscellaneous shapes and plates. The American Railway and Maintenance of Way Association and the Master Car Builders' Association also issue standard specifications

for sheet steels, rails, castings and equipment. Many important tests are made the subjects for work of sub-committees appointed by the International Petroleum Commission. The National Paint Manufacturers' Association also collects and publishes some valuable information in regard to paints. In weather tests of paints, for instance, it found that the colored paints were better preserved than the untinted white paints. Color seemed to reduce chalking, checking and general disintegration. This condition was held to be due to the reinforcing value of color pigments.

Most fields of industry have such trade associations, from which the manufacturer can obtain aid in setting standards for his purchasing, production and inspection departments. The movement has no doubt been accelerated by the work of the Underwriters' Laboratories in standardizing fire-prevention and fire-fighting equipment.

The specifications for testing followed by the Laboratories chiefly are those set up by the National Fire Protection Association. This is a body composed of men vitally interested in the subject of fire protection—insurance men, fire marshals, inspectors, architects and engineers. Between it and the National Board of Underwriters, under whose supervision the Laboratories is operated, there is the closest cooperation.

In electrical matters, the National Electric Code is followed. This is prepared and continually is being revised by a committee of the National Fire Protection Association composed of representatives from this association, the National Board of Underwriters, the Associated Factory Mutual Fire Insurance Companies, the American Institute of Electrical Engineers, the National Electric Light Association, the American Electric Railway Association, the National Electrical Contractors' Association and the National Association of Electrical Inspectors. So the association represents engineering skill very broadly and is in a position to set fair and practical standards.

Anyone may avail himself of the offices of the Laboratories for the purpose of having new devices tried out. But only when a maker submits his product for examination in accordance with the specifications of the National Fire Protection Association or the National Electrical Code is a report promulgated broadcast to the trade.

For this special testing a small charge is exacted, which merely covers the actual expense plus operating overhead. The time and cost depend altogether on the character of the material or appliance submitted. If it falls within the province of existing standards and can be put through in a routine manner, the time required is from four to ten days and the cost is small. If, however, new test methods must be originated, involving perhaps the use of specially designed apparatus, the time may run into months and the cost into hundreds of dollars. Any investigation that has a bearing upon the fire hazard is gladly undertaken.

To illustrate the value of the service performed on occasion by the Laboratories' experts, this instance may be cited: A manufacturer of electrical specialties, desiring the underwriter's approval on his make of electric flat-iron, sent in a sample for test. Now irons with rest attachments are tested, among other points, for length of time the iron can stand on its rest in contact with inflammable material without setting it on fire. The sample submitted proved weak in this respect. Acting on the suggestion of the test engineer, the maker lengthened the rest attachment and replaced the two side lugs which bore against the hot part of the iron with a single central lug. The iron then passed a satisfactory test in every respect. While the chief function of the laboratories is to register an opinion "yes" or "no"—"standard" or "substandard"—"approved" or "not approved," the engineers frequently volunteer constructive criticism of this sort which is of real value to manufacturers.

Government publications also prove a help to the manufacturer in specifying materials. The scope of the investigations of the Department of the Interior is constantly widening. Of the current reports, those on the treatment of ores and metals, and on fuel efficiency have unusual value. The National Bureau of Standards at Washington is another valuable source of guidance, although its work is mostly in the direction of setting up primary standards for private and commercial laboratories to follow. On the various supplies used by the government, however, it carries out tests in great detail, and the published findings are available for the public. Some testing for private persons along the same line is also done. To standardize testing and measuring instruments is another function performed. By keeping in touch with

what the Bureau is doing, as well as by familiarizing himself with the kinds of devices it has found best, the manufacturer can avoid loading his factory laboratory with inferior and unsuitable testing equipment. To know what testing methods to follow and what apparatus to use is vital to the success of any private laboratory. The Bureau of Standards points the way.

Finally in seeking reliable data upon his materials, the manufacturer may well examine the published works of the engineering experiment stations and laboratories of our universities and educational institutions. They are paying more and more attention to manufacturing needs and are making genuine contributions to factory practice. They will always conduct special investigations and ordinarily charge only nominal fees to cover the cost of the materials used in the experiments.

Moreover, it is often possible to arrange with the college authorities to have thesis work directed into some channel in which the manufacturer seeks information that will help him set up better standards. Even more valuable are the results that may be obtained through the research work of graduate students, qualifying for advanced degrees. Some practical manufacturing problem is just what such students seek. One company interested in getting the rock-bottom facts in regard to its principal material established a fellowship at a large eastern technical university for this specific purpose, and its chief engineer cooperated with the student investigator in making his experiments. The results subsequently were published in the technical press and also were made the subject of a paper read before a national engineering society. Thus everybody interested in the material in question shared in the benefit.

Technical schools, especially the larger ones, offer unusual facilities for research work and tests, superior even to what the largest manufacturing establishments can afford. Such state institutions as the Universities of Minnesota, Illinois and Wisconsin are very closely identified with the industrial as well as the agricultural interests of the constituencies that support them.

Some of the commercial laboratories also offer exceptional facilities along cooperative lines, supplementing the work of company laboratories as well as placing at the disposal of small manufacturers the advantages of the large in the inspection and test

of purchases. One large eastern laboratory maintains private experimental rooms which the manufacturer may hire at a modest rental for any length of time he desires. Here he can install his expert for some special test and while conducting it in absolute secrecy, yet have all the facilities of the institution at his command. These laboratories are patronized by such concerns as the Western Electric Company and the General Electric Company, which, although they have well equipped laboratories of their own, yet do not feel justified in providing the equipment to handle every special test. Moreover, they believe it good policy to check up their own results occasionally by commanding the resources of an outside corps of experts.

Inspection and testing of materials before shipment is another service undertaken by the commercial laboratories, which the manufacturer himself can not well do except in isolated cases. This plan heads off unsatisfactory material at the supplier's factory and saves the purchaser from the annoyance and expense of returning rejected product. When, too, the quality of purchases can be determined in advance of receipt, the purchasing agent does not need to allow time for testing on the premises and so can work closer to his stock.

In setting up material standards, therefore, outside helps play an extremely important part. Many are free for the asking. Those that cost really justify themselves by the money they save; indeed, so great is the usual gain that, speaking in general, no manufacturer, however small, can afford not to avail himself of them.

XII

HOW TO DRAW SPECIFICATIONS

IN every specification two persons are vitally interested, the supplier and the purchaser of the material. It has, in fact, been stated that a specification is an attempt on the part of the consumer to tell the producer what he wants. As a result of this attitude, the early specification did little more than define "qualities required of the material." A rational specification goes beyond this. It recognizes the tangential interests of buyer and seller, and crystallizes buying policy at many points. It states, for instance, the method of sampling, tells how much material one sample shall represent, prescribes methods of testing either in whole or in part, the size of the test samples, and how to forward samples.

Other questions which now receive the attention of the buyer are: Would it not be advisable to buy in lots of the same size as the test involves? Shall the quality of the shipment be determined at the factory where the material is made, or after the shipment is received? Factory inspection obviously requires the presence of the buyer's inspector at the supplier's factory. This plan, of course, is not encouraged by the manufacturer who has in his plant many private unpatented processes in operation. He has, however, less reason for objecting when the buyer's inspection is done through a commercial laboratory, as mentioned in Chapter XI. For the laboratory's experts have only the one interest and besides can usually be relied on not to divulge any trade secrets they inadvertently discover. Moreover, their work is equally to the supplier's advantage, as it is calculated to save him the expense and annoyance of taking back goods.

Often those who ultimately receive the material (the storekeeper or the department foremen) can make certain inspections better and cheaper than any special official. This, hence, makes it necessary to put in the specification the proper instructions for such inspections. The result of these several requirements is that a modern specification is in many instances lengthy, if not at times unwieldy. In other cases it would almost seem that the wording could be more definite, for some manufacturers have a desire to deliver the lowest possible quality on a contract, while the testing chemist and engineer endeavor to enforce the specifications to the letter.

In preparing any specification the aim should be to incorporate information which may be needed by (1) the seller, (2) the chemist and engineer of tests or other inspectors, (3) the ultimate user of the material.

The first step to be taken is the collection of information from the various sources already discussed. Samples may be gathered from the works, and data attached thereto, as to whether the results obtained were good, fair, or bad. The chemical and physical properties of these samples are carefully noted along with their price and date of purchase. The qualities of these materials have been decided by actual service. Sometimes the service does not give so much information, or it takes a long period to determine which material is good and which is undesirable. In such instances a "provisional specification," on the basis of general knowledge, is issued and the material delivered is carefully watched to see how it behaves, as has been described in Chapter X.

Direct positive experiments, in some cases, are made with samples which have been obtained and analyzed, or with material which is now in use in the factory. This makes it possible to obtain more complete records than when older samples are examined. Those products which fail to give good results are very carefully examined, in order that their objectionable features or faulty constituents may be ruled out when the specifications are finally drawn.

In the accumulation of information it is desirable to pay a visit to the makers of the materials, and learn from them as far as possible the grade or quality which it is possible to maintain

20 SCHEDULE AND SPECIFICATIONS—Continued.

Item No.	Quantity Required.	CLASS No. 12—WAGONS AND WAGON FIXTURES—Continued. Deliverable packed in quantities as required.	Quantity Offered.	SAMPLES. No. 1, Price.	No. 2, Price.	No. 3, Price.	No. 4, Price.	No. 5, Price.	No. 6, Price.
		Wagons, etc.—Continued.							
		Wide track, equipped with hooded steel skein and box brake—							
100	5	no. $2\frac{1}{4}$ x 8 ins., tires 2 x $\frac{3}{4}$ in.							
101	2	no. 2 x 9 ins., tires $1\frac{1}{2}$ x $\frac{5}{8}$ in.							
102	1	no. 2 x 9 ins. tires 2 x $\frac{1}{2}$ in.							
103	2	no. $3\frac{1}{2}$ x 11 ins., tires 4 x $\frac{5}{8}$ in.							

All tires to be bolted with counterunk bolts through the center of tire and rim of each segment of the wheels. All gears to be bolted together with single bolts down through the plates of the sand bolsters, the center of hounds and axles, and through the hooded steel skeins, the flat iron bar, and brace underneath. The size of the bolts to be in proportion to the size of the wagons.

Narrow track 4 feet 6 inches, wide track 5 feet.

The sizes of tires specified above are supposed to be those in general use, and are not absolute. Bidders, therefore, have the option of offering others, being careful to specify in their bids the sizes they propose to furnish.

Sizes of bodies to be as follows:

Wagon.	Length.		Lower box.	Upper box.
Inches.	Feet.	Inches.	Inches.	Inches.
$2\frac{3}{4}$	10	0	13	8
3	10	6	13	8
$3\frac{1}{4}$	10	8	14	10
$3\frac{1}{2}$	10	8	14	10

All boxes to have bow staples.

Wagons to have one priming coat and two heavy coats of paint before varnishing, and to be subject to two inspections, one in the white when ready for painting, and the other when painted and ready for shipment.

SAMPLE OF 3-INCH WAGON IN THE WHITE (3 x $\frac{1}{2}$ INCH TIRES) TO REPRESENT QUALITY OF ALL SIZES OFFERED MUST BE SUBMITTED BY BIDDERS.

Separate prices are invited for—

		Bows, oak (according to specifications of item 35 in this class).							
		Spring seats							
		Top boxes							
104	607	no. Whiffletrees, hickory, wagon, oval, $2\frac{1}{4}$ x $2\frac{1}{2}$ inches center, 34 inches long, full-ironed, with wrought strap irons and hooks at ends and iron ring at center clip; tied, in bundles.							

FORM XXV: When the United States Government makes a purchase, all the requirements are carefully and definitely stated. A page from a typical government specification sheet is here reproduced. "Of quality equal, to last lot" is a type of loose term never found in such specifications, and is permitted less and less in the specifications of progressive manufacturers

in commerce when proper precautions are used. No specifications should be drawn without a fair knowledge of the manufacturing process for the material.

An important factor which enters into the framing of specifications is the information procured from experienced men

as to the characteristics and the behavior of materials which have been used for many years. Great care is taken by large corporations in conducting all these preliminary investigations. One company, for instance, frequently works for two or three years before printing final specifications.

When all possible information has been accumulated, it is discussed and criticised, and a "provisional" specification is framed. All information which is not strictly relevant to the specification is omitted. If a hitherto untested material is about to be bought on specification, it may be necessary to alter the method of manufacture; and if this change is too drastic, the manufacturers of that material may resist any attempt at delivery on specification. This is a state of affairs which distinctly is to be avoided by the buyer, for it may make it impossible for him to supply his wants in the market.

After the preliminary specification is drawn, the chief chemist, the chief engineer, the technical superintendent and the purchasing agent all criticise the draft, making corrections and suggestions, eliminating non-essentials and adding necessary paragraphs. The printed copy is placed in the hands of the foreman of each department where the material is to be used. It is then sent to all those manufacturers of the material, from whom the purchasing agent considers buying. In every case the freest possible criticism is welcome.

The manufacturer's criticism, previous to the final publication of a specification, is today regarded as a most important part of the proceeding. The old idea that the consumer was to dictate to the manufacturer what was wanted, has given way to the broader view that the specification should represent the best that is known on the subject, without regard to the source of the information. To make a "lopsided" contract is unwise, unfair and certainly short-sighted. The manufacturer must be able to see that he has actually had a part in the making of the specification.

After criticisms are received from all those qualified to criticise, the provisional specification is remodeled so as to include all suggestions which are of actual value. In some cases criticisms conflict, but this is frequently due to local conditions and unimportant details. In the whole procedure there is one pre-

eminent feature that seems worthy of careful consideration, namely—the greater the care, the more study and well-directed time and effort, put upon the specification before it is issued,

STORING DATA FOR SPECIFICATIONS

STEEL BARS

1. Our regular run of bars, of which we use hundreds of tons each year, is specified by us as Soft Steel. We should also specify "In 15- to 20-foot lengths," unless we order to a specified or to a multiple length.

2. The next grade of steel would probably be what we call Dead Soft Steel to Weld; this is used principally for such items as—— (a list of the articles is given).

3. We also use what is known as Hard Steel, running from .20 to .30 Carbon up to .50 to .60 Carbon. The larger percentage of this Hard Steel is principally .30 to .40 Carbon for——. This material should also be ordered in 15- to 20-foot lengths, unless to a specified or to a multiple length.

4. SPECIAL NOTE.—In ordering Soft Steel, Dead Soft Steel, Plow Steel (not Plow Steel Shapes), Spring Steel, Hard Steel, always bear in mind the following: Do not specify less than a ton if the size in question is one for which we have other uses and of which we will use at least a ton a year. For any length under five feet there is an additional charge for cutting, for any quantity under a ton there is an extra charge, and a much larger extra charge if the quantity is under a half ton. Whenever it is necessary to know the analysis, either chemical or physical, the steel mills will supply test sheets; these, however, should be requested in the order, otherwise there may be a delay in securing them.

SCRAP—VARIOUS GRADES—PURCHASED

1. Cast Iron Scrap. There are numerous grades of Cast Iron Scrap. The best quality for our particular work is secured from broken up engine frames, fly-wheels, pulleys, and other scrap of that nature. This scrap should all be broken up into what we call one-man pieces, or pieces which one man can handle and place on a truck without assistance. This kind of scrap is what is known as Strictly No. 1 Machinery Cast Scrap.

2. Next to this comes what the railroads sell as Light Cast Iron. This is usually axle boxes, bumpers, and so on, not brake shoes.

3. SPECIAL NOTE.—There are three grades of Cast Iron, and the grade governs the price; that is, if No. 1 Machinery Cast Scrap was selling at $16.00 per gross ton, delivered, Plow Casting Scrap would be several dollars lower per gross ton, and Stove Plate Scrap would be still lower.

FIGURE VIII: To preserve the odds and ends of information which cannot readily be distributed on quotation cards, and to make the work of preparing specifications easier for a substitute or successor, data, such as that shown, was collected, item by item, from the buyer's personal experience

the less will probably be the difficulty connected with it after it has once become a part of the contract. A rational specification represents the fruition of the studies of those who investigate

the properties of such materials and those who handle and use these commodities.

Specification drawing, thus, like the preparation of instruction cards and standard instructions for the guidance of the factory, is a job for a specialist. Specifications, in fact, are standard instructions. Therefore it is essential for best results to have some one man in the organization specially qualified along this line. Large plants can well afford to have a material engineer, whose province is not only to accumulate the data for, and draw up the specifications, but to supervise the inspection and tests of receipts. Small factories, of course, seldom can carry such a man. It then falls to the lot of the purchasing agent to handle the job.

Now, anybody can write a specification, such as it is. But to prepare a specification that satisfies the requirements of scientific accuracy calls for special ability. In the course of time, however, by systematically saving and indexing every scrap of information bearing on specifications he can find, including specimens of actual specifications and model specifications such as technical societies and trade associations publish, any live purchasing agent can make himself fairly competent.

As examples of the kind of information to be collected by a buyer who has to shoulder the burden of specification and contract making, excerpts from one buyer's carefully indexed data book are shown in Figure VIII.

These notes are typewritten and kept in a special binder, readily accessible to all who are interested. New data are being constantly added; old data changed as conditions of the market and the business require.

Every purchasing man who has held one position any length of time, naturally accumulates a mass of such detailed information on the materials he regularly is called upon to buy. The more important technical details, which are difficult to hold in mind, some jot down in private notebooks. But by getting it all down in standard form as described, not only is the person in regular charge benefited, but should he for any reason temporarily or permanently be obliged to give way to another who lacks the same experience, the organization does not suffer.

Regardless of who prepares the specifications, the manager

should take a vital interest in their final form and attach his signature in approval. In some plants where the committee system of management is in vogue, it is part of the work of the purchase committee to approve specifications. Mr. D. S. Felt, president of the Felt & Tarrant Company, considers the matter so important that he allows no specification to be issued or to be altered in the slightest degree without personally passing on it.

Even specifications can be standardized, that is, put on the interchangeable-part basis. Many paragraphs, if not whole sections, often are common to a number of specifications and some to all. Business sense, therefore, dictates that matters which are common or can without sacrifice of substance be made identical, be designated accordingly. In making up a new specification, the writer then can simply refer by index number to standard paragraphs and be obliged to prepare afresh only what is absolutely new and different. Specification writers for big architectural and engineering firms make this their regular practice. To build a specification from the ground up each time involves a tremendous amount of duplicated and therefore waste effort, and in a plant having much of this kind of work, standardization of the preparation means a steady financial saving.

A GOOD SPECIFICATION IS BASED ON BOTH SERVICE AND LABORATORY TESTS

WHEN specifications on steel were first issued there was opposition on the part of the steel mills to the inclusion of chemical data in the specifications. They claimed that the consumer should only specify the physical properties of the metal, and exclude or limit by chemical data only the objectionable constituents. The steel maker then would be free to vary those constituents according to his own ideas. The most valuable properties of steel, however, depend upon those constituents. A certain set of physical properties produced in steel by high carbon and low manganese may yield a steel more valuable to the consumer than approximately the same physical properties produced by lower carbon and higher manganese, or other interchange of the constituents that commonly affect the physical properties of steel. A good specification must, therefore, be the result of the joint effort of those who know steel from its behavior

while it is being manufactured, and of those who know it from its behavior while in service.

There is no hard and fast rule as to the weight or volume of material which should be represented by one sample. When the material is made in batches, any sample taken will obviously represent that batch.

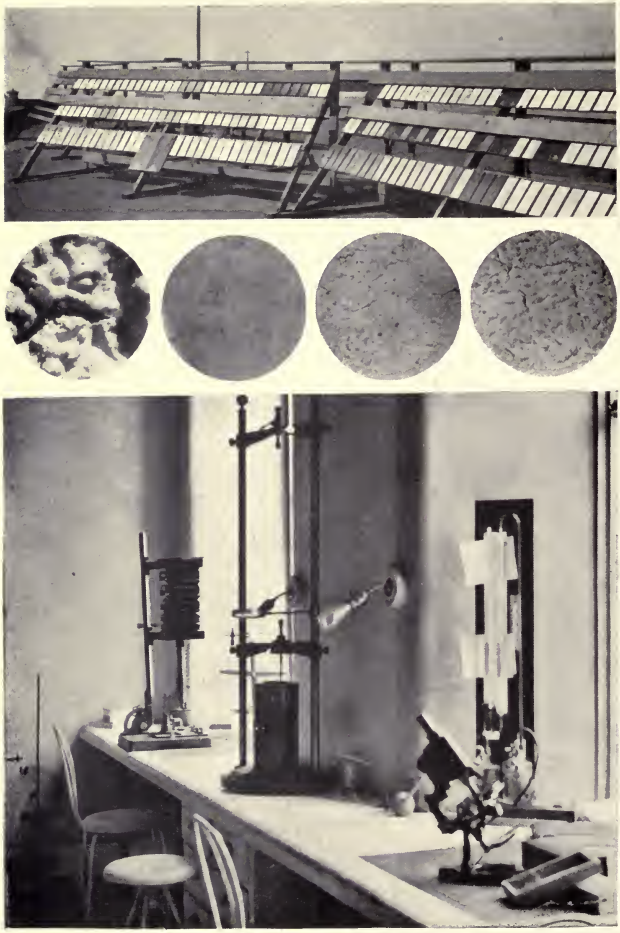
When a carload of iron reaches the yards in a certain foundry, this inspection routine follows: Four pigs are taken from different parts of the car. These are broken in two and one piece of each is sent to the laboratory. Here the four pieces are drilled and the shavings are intimately mixed. The result is a representative sample of the whole carload. The mixture is analyzed for silicon, sulphur, phosphorus, manganese and carbons. If it proves to be up to the specifications, the laboratory O. K.'s the car and it is unloaded. If the sample is not up to grade, six other pigs are taken from the car and another analysis is made from these. In the majority of cases the second analysis checks the first. The O. K.'d analysis is sent to the operating department and there becomes the basis for mixing the iron for the furnaces.

In the case of paints the question of sampling is more difficult. Such shipments are made up of material resulting from a number of like operations, without any certainty as to the uniformity in the output of each complete operation. The sampling must necessarily be rather arbitrary; but if there should be any indication of lack of uniformity in the shipment, an amendment of the specifications is probably called for.

How many individual parts shall constitute a sample, is a question that often comes up. In a shipment of ten tons of soap, shall one pound be taken for examination or shall several pounds be taken from different parts of the shipment? If fifty barrels of linseed oil are received, shall one barrel be sampled, or every barrel? In the more generous interpretation of a specification the shipment is presumed to be uniform and unimportant variations are neglected.

When a shipment is received, sampled in the prescribed way, tested, and found wanting—what then? The producer usually asks for another test, in the hope that this may show more favorable results and allow the material to slip in. If the second

Testing for quality is a highly developed function in the plant of the International Stock Food Company, at Minneapolis, whose product in the making requires accurate laboratory analysis. Results are carefully tabulated by a stenographer. Such equipment as that shown puts the purchasing agent in a position of independence in dealing with his markets and gives him definite knowledge on which to base his entire buying campaign



Actual weather tests have enabled purchasing agents to buy such items as paint with little or no guesswork as to quality. Above are shown racks on a factory roof where standardized paint samples of different colors are undergoing accurate comparative tests. Samples are later examined under a microscope. The discs are microscopic photographs showing the degrees of cracking and scaling

test is favorable, the consumer is naturally anxious to make a third, or "decision test." Specifications are not drawn for the purpose of making it easy for irregular or carelessly-made material to be accepted. It is far better to make the limits of the specification wide enough, when it is first drawn, so that they will cover all the uncertainties of manufacture, and eliminate carelessness, bad judgment, or any other attempt to sell an inferior product at the price of a good one.

TWENTY-FOUR STANDARD RULES FOR DRAWING SOUND SPECIFICATIONS

ANOTHER problem which arises in connection with "specification purchases" is to prevent material from being offered again which has once been rejected. Our federal government in some cases marks the rejected shipment and thus lowers the value of the material. The manufacturer is compelled to cover himself by raising his prices. Even this "branding" is impossible for oils, so that in this case the difficulty is partially obviated by putting a clause in the contract providing that the manufacturer must pay the return freight on rejected material. If the buyer observes that any vendor habitually returns rejected goods, he should simply refuse to accept future bids from that firm.

Many manufacturers object to specifications on the ground that they are annoying and really serve no good purpose; on the other hand, other producers distinctly request them. Some consider a difficult specification a direct advantage, as it eliminates the competition of inferior products. It should always be borne in mind that low prices must be the result of unusual manufacturing facilities or, as is more frequently the case, that low prices indicate poor quality.

In many cases the consumer is afraid to adopt specifications, thinking that the price of the product will be raised by the producer. Experience has shown, however, that after the producers have become accustomed to the new specifications, their prices invariably drop to a greater or less extent. This course may be due to three facts: all bidders are making prices on the same quality of goods; the material which is defined in a specification

is what might be termed "standard material," so that the manufacturer can without great risk fill in idle time with its manufacture; since the material is "standard," the manufacturer without fear of loss can purchase the constituents in a favorable market.

Cooperation among the plants in a given industry, through associations, is especially useful in this connection. Whereas the adoption by a single factory of a policy of buying only on specifications might work a hardship to that particular factory, if all the plants in the industry agree to buy only on this basis, the suppliers are quickly brought into line and no one suffers. It is also possible for such an association to have uniform specifications on many of their materials, and one group of manufacturers are even doing their purchasing in common.

The problems which arise in the drawing of specifications are covered by the rules laid down at various times by the late Dr. Charles Benjamin Dudley, president of the International Association for Testing Materials and the American Society for Testing Materials. The precautions which he suggested in his personal interviews, and in his practice, are the result of careful thought by a man unusually well-fitted for the task. They are:

(1) A specification should not attempt too much nor be too complicated.

(2) Well-known methods of analysis or testing should be referred to only in a general way.

(3) Well-known precautions to be observed by the inspector should not be explained in detail.

(4) New methods of analysis or testing, not well known, must be described in detail, or reference must be made to the original publication.

(5) Analyses like those of soap and oils, which are not conducted in the same manner by all chemists, should be issued in separate pages and made a part of the specification.

(6) When drawing up a specification do not incorporate in it all you know about that particular subject.

(7) Do not put too many restrictions into the specifications, but state as few tests as are necessary to yield the product required.

(8) Do not make the limits too severe. If you tie the manu-

facturer down to the extreme limit, you place him in absolute antagonism.

(9) It is better to specify a good average material, and get the necessary protection of machines and processes by a more liberal factor of supervision and technical knowledge, rather than to insist on extreme limits, which can only lead to constant friction and a demand for concessions.

(10) Do not think that the most perfect specimen of a certain product should be made to represent the total output of the works. The use of such extreme figures is one of the worst possible mistakes observed in some specifications.

(11) All parties whose interests are affected by a specification should have a voice in its preparation.

(12) The limitations contained in a specification may be derived from any source of knowledge, and the tests may be microscopic, physical or chemical.

(13) The specification should contain all the information which is needed by those who are to enforce it. This includes the chemist, the engineer, the purchasing agent and the superintendent.

(14) The service which the material is to perform, in connection with reasonable possibilities in its manufacture, should determine the limitations of a specification.

(15) Proprietary articles and products made by processes under the control of the manufacturer cannot be made the subject of specifications. The consumer, however, may determine the chemical and physical properties of any preparation and incorporate these in a specification.

(16) The sample for testing must always be taken at random. The amount of material represented by one sample must be determined by the nature of the material, its value, its probable uniformity, and its importance.

(17) Average samples, made up of a number of samples, should only be prepared in cases where the limits of the specifications are so narrow that they do not cover the ordinary irregularities of good practice in manufacture.

(18) Retests of material which has once been rejected should be allowed only on very good grounds. They are justified when there is a doubt as to the exactness of a test.

(19) If it is desired to sell rejected material to a consumer, after it has been rejected by him, a concession in price must be made.

(20) When a consumer has purchased material on specification it is unfair to ask of the manufacturer guarantee of the behavior of the material in service.

(21) It should as a rule be unnecessary to mark rejected material when dealing with reputable firms, but if this *is* necessary, an inconspicuous private mark may be applied. In any case the manufacturer should be obliged to pay return freight on rejected goods.

(22) Specifications should be examined, and if necessary revised, six months after they have first been put into force. This makes it possible to introduce the knowledge gained by actual usage.

(23) In testing materials, if the results are just outside of the prescribed limits, allowance should be made for error.

(24) A complete workable specification should harmonize the naturally antagonistic interests of producer and consumer. It should have the fewest requirements consistent with securing satisfactory material; should leave no chance for ambiguity; and above all, it should embody the results of the latest studies of the properties of the material.

Part III

STOREKEEPING

AUTHORITIES AND SOURCES

FOR PART III

Chapter XIII. Contributed by Mr. Porter from his investigations and experience with storekeeping methods in both small and large factories in various lines.

Chapter XIV. Contributed by members of the editorial staff of FACTORY, with J. W. Wiley, assistant secretary, The Meyercord Company, collaborating. The chapter is based upon a study of indexing methods in more than a score of factories.

Chapter XV. Contributed by Mr. Feiker and Mr. Porter. Reference is made to the plants of the Whitney Manufacturing Company, Kohler Company, Hart-Parr Company, Thomas B. Jeffery Company, and Hendee Manufacturing Company. Among the lines to which particular reference is made are cutlery, range finders, machine tools, electric locomotives, transmission machinery, brushes, and electrical devices.

Chapter XVI presents the results of an investigation by Mr. Porter. Illustrations are given of the delivery methods of Lodge & Shipley Machine Tool Company, Bethlehem Steel Works, Hart-Parr Company, Ford Motor Company, General Electric Company, Whitney Manufacturing Company, Willys-Overland Company, Kohler Company, and others.

Chapter XVII. Contributed by Ford W. Harris, consulting engineer, formerly with the Westinghouse Electric & Manufacturing Company, and Henry M. Wood, Lodge & Shipley Machine Tool Company.

Chapter XVIII. Chiefly contributed by Chester R. Reed, purchasing agent, Reed & Prince Manufacturing Company; with S. B. Rogers, Sangamon Electric Company, collaborating.

Chapter XIX: This chapter was written from the experience of the following: H. W. Coleman, superintendent, Lidgerwood Manufacturing Company; A. C. Carlisle, purchasing agent, Studebaker Manufacturing Company; L. E. King, Union Model Works; Frank W. Birdseye, Chalmers Motor Company; Wilfred G. Astle, The Toronto Electric Light Company; Louis C. West, and Mr. Porter. In addition to the firms already mentioned, reference is made to a Cleveland manufacturing plant, Elgin Watch Company, Ford Motor Company, H. H. Franklin Manufacturing Company, Joseph T. Ryerson and Son, Detroit Lubricator Company, Northway Motors & Manufacturing Company, a New York electrical company, and a machine company.

XIII

CONTROLLING STORES LIKE CASH

ALMOST invariably when a factory manager calls in an efficiency expert to help him in fixing more definite routine methods and putting in useful systems, an initial point of attack is the stores. And it is by no means unusual for so large a saving to be shown the first year on this one item, as to repay several times over the expense of systematizing the entire plant. Materials are but cash in a less fluid form and it pays to handle them with similar care. The fact that poor control of stores is one of the largest sources of loss in American industry is a challenge to every manager who faces his present costs with concern.

Directly the principal sources of loss are three. First, wasteful use of materials and supplies—particularly supplies—which always obtains where workmen have free access to stores, since issuance is then not checked, and standards of consumption are totally lacking. This is not surprising, since it is a universal tendency to be careless in the use of what belongs to another. This tendency in the shop can only be curbed by requiring strict accounting for all materials issued. Twenty-five per cent excess consumption on this score alone is not extraordinary.

Second, appropriation of company material for private purposes. This also seems to be a natural and inevitable accompaniment of lax control, and in some cases has reached such proportions as seriously to impair profits. In the average instance, what one man appropriates in the course of a year does not amount to much and it is chiefly because he takes this view of it that, without particular scruples, he continues the

practice until finally he comes to consider that he is only taking what is his right. This is why, mainly, he so stubbornly opposes the inauguration of any scheme which means the curtailing of his privilege.

Out-and-out thievery is the third direct source of loss. This in the average industry amounts to little, but in certain lines may constitute the largest single item of loss. It all depends on the character of the stores. Articles and materials of small bulk but high value, which easily may be concealed about the person or secreted in a dinner pail, and which find a ready market as junk, constitute a temptation to which even the highest grade of workman sometimes succumbs. Copper and brass, in the form of wire, hardware or scrap are such materials.

While it is true that apprehension and arrest of shop culprits has the desired effect for a while, in a few weeks or months the lesson is forgotten, and conditions again become as bad as ever. Proper storekeeping and accounting methods, however, put a permanent stop to the trouble.

Indirectly there are several other sources of loss. For one, lack of standards of consumption and of rigid control over issuance almost invariably means the carrying, in aggregate, of a larger stock than actually is necessary. This amounts to a wasteful employment of working capital, and in interest on the excess investment and a heavier depreciation on stores constitutes a direct charge against profits. In a typical instance, at the end of the first year following the over-hauling of the storekeeping methods, it was found that in spite of a growing business the factory had been able to get along with less stock by twenty thousand dollars than previously. This at five per cent represents a saving of one thousand dollars annually in interest charges. In the average instance further savings also result through the avoidance of superseded materials. By controlling the supply statistically, it is possible not only to keep the quantity of all items on hand always close to the minimum, but gradually to exhaust any materials that a contemplated alteration in the design of the product will make unnecessary, so that when the old style is dropped the discard is practically nil.

Production delays on account of shortages, although a less tangible source of loss, nevertheless are among the largest

negative factors in the problem. To eliminate these alone is, in the average case, worth all the time, energy and money required to rectify the control of stores. For of all the evil fruits of laxity, shortages are the most baneful in their effect upon production efficiency. Literally these tie up the wheels of industry.

Usually, also, where laxity obtains in this department of an industry, there is a lack of centralization as well. This means the occupancy of valuable producing space about the factory for storages. As a result, although the aim—in abstract laudable enough—is to keep materials as handy as possible to the point of utilization, production is impeded, a strict accounting is made very difficult if not impracticable and, through the inefficient piling of materials, and the resultant requirement of larger space for storages, every square foot of producing space is burdened with a higher overhead charge.

Integrating all these losses—if this were possible—makes their elimination by the adaptation of a proper stores system a matter of prime importance. Systematizers as a rule make no mistake in electing stores an initial point of attack.

The first step is to consolidate all the stores in one or more centrally located storerooms or store places, to close off these from the rest of the factory, and to place a keeper in charge who is under instructions to issue no materials whatever, except on receipt of a duly authorized requisition signed by a foreman or other responsible head.

Materials like lumber, pig iron and sand, whose bulk is large and relative value small, of course do not require these same precautions. Nevertheless it is essential to establish a definite responsibility even for their keeping and to allow only designated persons, for a stated purpose, to take from the pile. In case of the particular materials mentioned, which usually are stored in the open, the yard foreman is a proper official to name as keeper and he should be required to render daily a report in detail of materials that have gone into the works—also of fresh supplies that have been received.

It may be argued that only a large factory could afford to carry out completely these precautions. To some extent size is a limiting factor. Certainly it does not seem a profitable

procedure to tie down a good man to a storeroom when only a small part of his time will be required. However, there is usually a way out. A small woodworking plant found it possible to combine the functions of storekeeper and cost clerk in one man and thus secured the full value of his time.

In other cases, some piece of equipment, perhaps a small lathe or a grinding machine, has been brought into the storeroom and the operator made responsible for the stores as well. Still another expedient is to have "office hours" for the storeroom. During a set hour each morning, and if necessary, again in the afternoon, a foreman, a trusted workman, the time clerk, or even the bookkeeper, takes possession and opens up the window for the filling of requisitions. The foremen then arrange to get materials only during these hours and between times it is impossible to gain access to the stores without going to the superintendent himself. A small cutlery manufacturer is one who found in this device a satisfactory solution of his problem.

INDEXING AND FILING MATERIALS AND SUPPLIES FOR AUTOMATIC ACCOUNTING

AXIOMATIC also is it that a suitable system of filing and indexing stores be provided. There must be a place for each article or material, and this must be determined principally with a view to greatest facility in issuance. It is also essential that the space be utilized as efficiently as practicable, in order that the space charges for storage purposes be minimum. As far as possible, furthermore, the bins or racks should be arranged so that the keeper can tell at a glance how his supply is holding out. If, in addition, the arrangement can be made to show automatically when the low limit has been reached on any item, so much the better. If not, the keeper should, in general, be required to operate a record of receipts and disbursements, so that as a matter of figures he knows exactly the balance on hand. Tags, suitably columned, which are attached to the bin or frame of the rack, have been found quite convenient for this purpose.

As a check on the storekeeper, office records also are operated which keep constantly in view the balance of each material on hand. These may take the form of cards or of sheets (Form XXIX) in a looseleaf binder. In special cases it may even be

REQUISITION FOR OUTSIDE MATERIAL

NUMBER	PURCHASE ORDER NO.	DEPARTMENT	DATE ISSUED	DATE WANTED
439	1265	Foundry	1-5-15	Soon as possible

QUANTITY	ARTICLE AND DESCRIPTION
2 sets	Small door hinges, for wood doors, foundry office, as on p. 603, L + S. catalog

QUANTITY ON HAND	APPROVED	SIGNED

STOCK REQUISITION

DATE	DEPARTMENT	EXPENSE ACCOUNT	PRODUCTION ORDER
2-9-15	Mill	Sanding	349

QUANTITY	ARTICLE AND DESCRIPTION	FILLED IN BY OFFICE PRICE	AMOUNT
1 doz. sheets	#2 sandpaper, for drum sanders	.04	.48

DEDUCTED FROM INVENTORY	ENT. COST RECORD	DELIVERED BY	DELIVERED TO	SIGNED
J. B.	S.L.K.	#205	Foreman, Mill	L.J.R.

RECEIVING RECORD

RECEIPT NO.	FREIGHT BILL NO.	FREIGHT BILL DATE	FREIGHT OR EXPRESS	DATE SHIP'D	DATE REC'D
4680	11693	2-9-15	$0.75	2-8-15	2-12-15

FROM Excelsior Hardware Supply Co.

QUANTITY	ARTICLE AND DESCRIPTION
3 kegs	#8 Wire Nails

CONDITION		
O.K.		

CHECKED PURCHASE ORDER	ENT. INVENTORY	RECEIVED BY
R.C.M.	F.M.K.	John Cassidy

FORMS XXVI–XXVIII: To reduce to a routine the requisitioning of outside material and the checking of stock-room receipts and disbursements, these three forms are useful. The requisitions furnish the information by which the balance on hand is diminished. The receiving records and the reports of new material give information by which the balance is increased

possible to adapt a graphic accounting scheme on some items and thus cut down cost of clerical work.

Whatever the form or character of the recording device, it should start with an actual physical inventory as the basis. Stock requisitions (Form XXVII), signed by the storekeeper, then furnish the information by which the balance on hand is diminished, and receiving records (Form XXVIII), when checked with the storekeeper's reports of new materials added to the stock, the information by which the balance is increased.

It is also well to operate, on the same form, a record of purchase orders—number and date of order, quantity, vendor and when delivery is promised. Then, in event of an unusual consumption, the record (Form XXIX) shows how soon a fresh supply will be available.

Further data needed on the inventory form, in addition to the name of the article, price, filing symbol and place of storage, are the high and low quantity limits, the desirable ordering quantity and the daily, weekly or monthly requirement. The last should be very carefully determined and periodically the actual compared with the theoretical consumption. This information in the hands of the executive is an effective instrument of control.

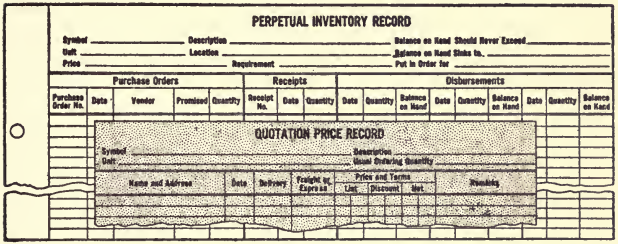
The names of suppliers, their respective quotations, freight charges (if not included in the price) and usual interval of delivery also are often noted on this form, where they prove exceedingly convenient for use. But ordinarily space limitations forbid their inclusion and a separate record is provided such as Form XXX.

HOW THE STOCK RECORD CAN BE MADE TO SHOW WHEN NEW PURCHASES ARE NECESSARY

IN factories that make to customers' orders, the stock record is capable of still another service. No regular requirements can in this case be stated and the maximum and minimum limits become, at best, only rough guides. By adding to the form a column for the entry of quantities needed for orders just received, and a second balance-on-hand column, the net balance, from which all known requirements have been deducted, can be carried alongside the actual physical balance, and thus the need

for fresh purchases shown up at the earliest possible moment.

Such systematizing is sound business policy. No manufacturer would think of issuing checks against an unknown bank balance; nor if he found his accounts payable at any time likely to exceed his cash account, would he delay to make provision for an ade-


PERPETUAL INVENTORY RECORD

Symbol _____ Description _____ Balance on Hand Should Never Exceed _____

Unit _____ Location _____ Balance on Hand Sinks to _____

Price _____ Requirement _____ Put in Order for _____

Purchase Orders					Receipts				Disbursements								
Purchase Order No.	Date	Vendor	Promised	Quantity	Receipt No.	Date	Quantity	Date	Quantity	Balance on Hand	Date	Quantity	Balance on Hand	Date	Quantity	Balance on Hand

QUOTATION PRICE RECORD

Symbol _____ Description _____

Unit _____ Usual Ordering Quantity _____

Name and Address	Date	Delivery	Freight or Express	Prices and Terms			Remarks
				List	Discount	Net	

FORMS XXIX and XXX: The perpetual inventory record is a complete history of the purchase receipt and disbursement of any item. It shows constantly the quantity on hand and indicates by the rate of consumption how soon another supply will be needed. Inventory and price records may be made up either as sheets for looseleaf binding or as cards for filing

quate supply when the critical due-date arrived. No less should he be correspondingly provident as to the adequacy at all times of his stock supply.

If it is valuable for the manufacturer to have in mind constantly the cash-control idea with regard to his stores, it is no less helpful to get the workmen imbued with the same idea. The very fact that the stores are under lock and key and may be obtained only by getting the O. K. of a foreman, exerts a strong influence in this direction. It is a psychological truth that the easier a thing is to get the less is the value at which it is held. This is not to say that issuance should be so surrounded with safeguards and restrictions as to put workmen to inconvenience in securing necessary supplies. On the contrary, the getting of needed materials should be facilitated as much as possible. But any wasteful use must be discouraged absolutely.

To accomplish these ends, standards of consumption are obviously indispensable. The management cannot know when restriction becomes a nuisance and a loss unless they are fortified with positive knowledge of the requirements. Then they can say with force to the shop: "This is your allowance—for any excess we must in every case know the reasons."

When a management is in this commanding position, the workman's sense of value assumes its normal; and the proper degree of carefulness in the use of materials and supplies follows. Then, and then only, does maximum economy in consumption of stores result.

The point is well illustrated by the experience of a New England manufacturer in regulating office use of pencils. Formerly, a liberal stock of these was kept in the supply vault, and anyone who needed a pencil simply helped himself. One day the purchasing agent began analyzing the bill for pencils. He made a few calculations as to the number used in a year by the average person. He compared the result with his own consumption. The disparity was astounding. Although he was a heavy user, the average figure was more than quadruple his own. He thereupon transferred the stock to his own desk, and, for a few weeks, personally controlled the issuance, keeping an accurate record by individuals of the number given out. That he was doing this he kept to himself. At the end of the first month the comparisons were illuminating. Although the fact that the office people no longer could help themselves, but had to come to him—a responsible head—in itself was a powerful counteractive to excessive use, some of the clerks had required two and three times the quantity used by others who were doing identically the same work. It was evident that these either were inordinately wasteful or that they were appropriating pencils for outside purposes.

So the next month the purchasing agent let it be evident that he was keeping an individual record. The effect was electrical, particularly on those whose records had been bad the previous month. Pencil consumption at their desks sank to about the same level as elsewhere, while the general level dropped nearly fifty per cent.

The third month the purchasing agent added the requirement that the stubs of the no-longer-usable pencils in every instance be returned and the exact equivalent in new ones only was issued. This had the effect of still further reducing the average.

Finally, satisfied that the minimum level had been reached, the purchasing agent compiled a schedule of individual requirements and notified the office that at the beginning of every month each person would receive so many pencils. Under no circumstances

would more be issued that month and if anyone ran out he must replenish his supply by outside purchase.

By this means the annual expense for pencils was cut from close to two hundred dollars to less than forty dollars—a saving of eighty per cent, certainly worth while and indicative of what can be accomplished by applying cash methods to stores.

Still further economies result, if whenever the standard is exceeded because of breakage or poor quality, the cause is investigated and steps taken to prevent a recurrence. An inordinate breakage of files on the part of one workman, as compared with the standard of allowance, and with the supply used by other workmen doing practically the same work, indicates one of two things; either that this man is unusually careless and therefore not worth retaining, or that he is sorely in need of instruction as to the proper use of a file. But if the average consumption of files shows a large increase over the limit set, an inferior grade would be indicated and the management can take immediate steps to obtain a better supply.

This contingency, of course, should not occur in a factory where purchases are made according to specification and are tested before acceptance, as in general is the only satisfactory practice. For standards of consumption, to be workable, must go hand in hand with standards of quality. To accept sub-standard articles and expect to translate them into standard performances, is like receiving money without regard to its genuineness and counting on getting the full equivalent in return, even though some of the dollars are counterfeit. So the cash parallel holds to the end.

Right materials plus right methods of control plus standards of consumption result in a product in which maximum value has been embodied.

XIV

HOW TO IDENTIFY AND INDEX STORES

CLASSIFICATION is the first step in the systematic arrangement and control of stores. The necessity for insurance against error in itself justifies the requisite outlay. But the contents of the storeroom of the average factory are moved about at the whim of the storekeeper. There is no regular place for any item. Sometimes there is a bin-tag with the name and quantity of the material, but more often no tag at all is used. Disorder and delay in finding supplies and materials follow. This delay is accentuated by the different designations of stores. The "shop" name for supplies and materials seldom is the trade name by which the storekeeper is likely to know the goods. Moreover, to write out the full name of an item is a waste of time. An abbreviated system of identification is in line with economical management.

A by-product of classification exists, however, which often more than pays for the expense entailed. When you begin to classify, you inevitably find superfluous items. Standardization, with the economy of larger purchases, results. A Chicago factory in the classification of stores found in stock repairs for five different kinds of rolling doors. The doors represented an accumulation of fifteen years. As the factory had grown and new departments had been added, doors of "any old type" had been hung. The betterment department now determined upon the door satisfactory for all factory purposes and today repairs for this type only are carried. Standardization reduced the total investment in door repairs and at the same time allowed the company to obtain the economy of larger purchases of repairs for

Just as the receiving room is best organized with one inlet, so the storeroom should have one carefully controlled outlet in order to keep the issuing of stores under the closest scrutiny of the management. This is the case in the stock-room for machine parts and thread at the factory of the W. L. Douglas Shoe Company. The small opening in the door discourages "visiting" between workman and stockkeeper

Stores represent cash and should be controlled accordingly. In one small plant the stockkeeper observes "office hours." In a tool and supply room, a lathe was installed, and the stockkeeper used his spare time in conditioning tools. Below is shown an arrangement of unit bins for raw stock. The register keeps a cash account of stores. The circle and arrow indicate adjustable shelf devices

one type. Similarly, classification showed twenty-six different kinds of cotton waste in use. Some foremen were using white waste, others colored, and all, waste of several grades. The waste best suited to average use was determined upon, with a resultant saving of fifty per cent in the annual outlay for this item. So an ever-increasing number of manufacturers are finding the advantages of classifying stores.

The requisites for a good system of classification are: (1) simplicity, (2) brevity, (3) definiteness, (4) flexibility, and (5) conformity to the other symbol systems which are, or may be installed in the factory.

How thoroughly you will classify or what system of classification you will adopt, depends largely upon the nature of your business, the probability of its continued growth and development, and what stage of progress in system it has reached.

Two general schemes of identification are in use—the mnemonic, or aid-to-memory system, and the numerical system. Where the diversity of stores is great the mnemonic is decidedly preferable to the numerical under most conditions. Its chief advantage lies in the rapidity with which everyone in the organization who has anything to do with stores and tools memorizes the symbols, so that reference to lists is unnecessary. The mnemonic system is in use wherever the Taylor system of scientific management has been installed, and the Taylor group of engineers are its chief exponents. Accountants as a rule prefer the numerical system. And where the business is simple and the variety of stores small, it is not difficult to memorize the few number classifications required. Then the numerical system is probably preferable. The numerical system also is probably better suited to businesses only partially systematized and to those that practically have ceased to expand. Moreover, even in a highly evolved and rapidly expanding business, if costs are summarized by mechanical means, the numerical system is often more convenient, as under the mnemonic system each symbol would require an accounting number in addition.

A choice, therefore, under any given set of conditions involves a nice balancing of advantages and disadvantages, and the most practical system may prove in the end to be a combination of the two.

In working out a mnemonic classification, the first step is to determine the groups into which the various items logically fall. Similarity in use rather than in kind is the determining factor. A class or group letter is first selected. This usually is the initial letter of the general classification. The rest of the symbol is then built up of other letters similarly chosen, each of which narrows the classification a step further until the identification is absolutely distinctive and the symbol cannot be confused with that of any other item.

General stores are designated "S." Stores for a *variety* of purposes are marked "SV." All materials for a specific purpose are grouped together. Materials for drill presses, for example, are so grouped and designated "SD." The second letter in the symbol indicates the purpose for which the material is to be used and usually is the initial letter of the word which expresses this fact. Subsequent letters in the symbols, whether for stores for specific purposes or for a variety of purposes, are arranged generally on the same basis. The third letter signifies the nature of the material, as "B" for bars in the symbol "SVB" (bars used for a variety of purposes), the fourth letter its general divisions, as "B" for brass and "C" for copper in the symbols "SVBB" (brass bars used for a variety of purposes), and "SVBC" (copper bars used for a variety of purposes), the fifth letter the kind of article in the last subdivision, as "H" for hexagonal and "N" for octagonal in the symbols "SVBBH" (hexagonal brass bars used for a variety of purposes), and "SVBBN" (octagonal brass bars used for a variety of purposes), and the sixth, if necessary, the manufacturer or make as "S" for the Simpson Company in the symbol "SVBBHS" (hexagonal brass bars used for a variety of purposes and manufactured by the Simpson Company).

In the above examples it will be noticed that "octagonal" is indicated by "N" in the symbol designating "Octagonal Brass Bars." This introduces some of the complications which arise in the mnemonic system. The letters "O" and "I" are never used in symbols and "J," "Q" and "U" rarely because of the great probability of the confusion of "I," "O" and "Q" with the numerals "1" and "0" and "J" and "U" with each other or "V." Again it often happens that the initial letter has

already been used for the division in question. In this case a secondary letter for the most prominent sound is used, as "N" for English in the symbol "SVPBN" for "English-Finished Book Papers used for a variety of purposes." If this letter also has been used, letters of the next most prominent sound are chosen. If all of these in turn have been used, arbitrary letters may be selected, but to be as mnemonic as possible, the next letter in the alphabet before or after the initial or the most prominent letter, if it is not already in use or likely to be used, is preferred. The letter "N" for "Octagonal" illustrates this point, as "N" was selected because it precedes "O." A purely arbitrary letter has to be used but rarely. Sometimes, however, letters which ordinarily would not be used at all in the classification are for that reason selected to indicate certain articles or classes of articles, as "Z" for "miscellaneous." Generally, those supplies and materials which move slowly or are bought in small quantities are grouped under "miscellaneous."

HOW TO NOTE DIMENSIONS ACCURATELY IN MARKING STORES

DIMENSIONS sometimes are stated after the entire symbol. The general practice, however, is to state the dimensions immediately after the first or second letters for the general designation of stores. Again, the manufacturer may be indicated by a subnumeral instead of a letter as stated above. Thus "SV 11 12 150 PB_1N" would mean "English-Finished Book Paper Made by the Ridgview Paper Company, Size 11x12, Weight 150 Pounds to the Ream and Used for a Variety of Purposes." Whenever numerals are used in subdivisions, these, of course, must be memorized. For this reason letters should be used wherever practicable. The point to remember in stating the dimensions is this: Be uniform. Give length, breadth, thickness, weight and similar data in a definite order for all items.

Lack of thoroughness in working out the groups is the chief danger of the mnemonic system. Great care must be exercised, as wrong groupings are worse than no groups at all. While the mnemonic system is the more complex at first, it is often better in the end, as under the numerical system an increasing amount of clerical labor is a certainty with the growth of the business.

The numerical system, however, is simple at the first and for this reason is in more general use than the mnemonic.

The system based upon numbers may be one of several forms, as arbitrary numbers, an arbitrary combination of numbers and letters, or a combination of arbitrary and mnemonic characters. For example, all material for molding machines may be designated "3," materials for particular types, as automatic stripping plate machines "3/1," core ramming machines "3/2," and so on. Sometimes numbers are given the mnemonic quality by grouping. In one plant numbers 900-950 denote eye bolts. A somewhat different plan is followed by an electric company. Screws, for instance, are indicated by "17," 170-179, 1700-1790, and so on. The first two digits indicate the class (screws), the third and fourth digits and so on, as far as it is necessary to carry out the system, signify the particular screw as to composition and other details.

Modified Dewey decimal systems also have been applied in a number of plants. Although this system was originated principally for library purposes, factory managers and engineers have found it useful for indexing technical data and information, catalogs, reports, card systems, drawings and other records. And there is no reason why stores cannot be indexed along the same line. The Dewey classification need not be literally followed, but a decimal system based on the same principle often will nicely fit particular conditions. In the Dewey system the first digit of the whole number indicates the primary classification; the second, the division of the primary; and the third, the section of the division. This part of the symbol is confined to these three digits. To the right of the decimal point successive numbers are added to represent finer subdivisions of the section. Thus, the symbol 625.23 stands for "passenger cars." Taking the digits in order, the first fixes the general classification, "Useful Arts;" the second, the division, "Engineering;" and the third, the section, "Railroad Engineering;" while the first digit after the decimal point indicates "Rolling Stock" and the second, the kind of rolling stock, in this case "passenger cars." Similarly 625.24 identifies freight cars. When more than three numbers are necessary to the right of the decimal point, a second decimal point is inserted, and if more than six a third, and so on.

Applying the same idea to stores, (1) might represent General Stores, (2) stores for a variety of purposes, and (3) stores for a specific purpose, as drill-press material. Then (12) would be interpreted as "stores for a variety of purposes," and (13) as "stores for drill presses." The third digit would represent the general character of the material, as sheets or bars. Numbers to the right of the decimal would amplify the description still further and even the size might be indicated by a numeral. Thus 124.631.2 might be the symbol for 1" hexagonal brass bars, used for a variety of purposes and manufactured by the Simpson Company. The value of such a system evidently is its brevity. Also it is to some degree mnemonic, as the order of the digits determines what each signifies. The disadvantage, as compared to the mnemonic, is, of course, the difficulty of remembering the numbers, the necessity for constant reference to cross-index records, and the liability of errors in either the numbers or the order in which they are written.

That the numbers often are not definite and are not suggestive of the article is the great disadvantage of any numerical system. Numerical grouping, however, may be given a slight mnemonic quality. In laying out a numerical system, you should group the supplies and materials logically and put forth every effort to make the classification mnemonic in a measure. Furthermore, it should conform as much as possible with the other symbol systems in the plant.

ARRANGING YOUR STOREROOM TO FIT THE CLASSIFICATION CHOSEN

IF the classification has been properly mapped out, the physical arrangement of the storeroom is not a very difficult task. Under the mnemonic system the supplies and materials are located alphabetically according to the respective symbols; under the numerical, they are placed generally in numerical succession. These numbers and mnemonic symbols, it will be recalled, are assigned on the basis of logical groupings, made with the nature and use of the material in mind. For example, it would not be expedient to group brass bars and brass castings together and give them the same class symbol, because they are both of the same metal. The logical classification would put the brass and

steel bars in the same group and likewise brass and steel castings.

Otherwise, in the physical arrangement of the room alphabetically or in numerical succession, duplication of special racks and bins would be necessitated. The numerical system, however, does not necessarily call for the arrangement of stores in numerical succession. In the absence of this method, one is dependent to a larger degree upon the index. The mnemonic system, it will be observed, is self-indexing, as materials and supplies are stored in alphabetical order. Their location may be shown by symbolic indexes posted at the end of the tiers. The storekeeper, for example, receives a requisition for an article the symbol of which appears as "SV8 10PL." He himself may not know what the item is. He passes by many of the tiers until he comes to the "SV" tier. Here he find the "P" bin and the "L" sub-compartment in which there are several little bins for different sizes. In one of these—8x10—he finds the item requisitioned—lining paper, 8x10 inches in size.

If you follow the numerical classification, the practice is to make both a numerical index and an alphabetical cross-index. The numerical index indicates the numbers and names of all the supplies and materials so designated, together with bin and aisle numbers. The alphabetical cross-index consists of individual cards with the names of all the stores and the corresponding numbers. The storekeeper can thus readily ascertain the exact location of any supplies or materials requisitioned, whether the order is by number or name. It sometimes happens that there are stores of little importance or kept under peculiar conditions so that their inclusion in an extensive classification is not desirable. In this case a simple index of these stores is sufficient.

No one fixed rule governs the actual storing of supplies. Generally speaking, storage with reference to use as under the mnemonic system, when stores are divided and subdivided into groups is the best practice. But it may be necessary to make an exception to this rule and place that material which moves frequently nearest the door if the alphabetical or numerical location prevents the arrangement of stores so that they may be delivered without delay and with the least effort. Whatever system of classification you adopt, rapidity of movement, size and shape and quality will be carefully considered, as the acid test of any

classification is the indexing and arrangement of all stores so that they may be given out in the minimum possible time.

For the classification of semi-finished and finished materials which may be in the stock-room the same principles of identification of stores also hold. Both the mnemonic and numerical systems have been satisfactorily applied for these materials.

That the use of mechanical sorting, tabulating and totalling devices in the accounting department makes necessary a numerical designation in addition to the mnemonic symbols, if these are employed, has been pointed out. This makes a complication which offhand seems to point the advantages of adopting a straight numerical system. However, there is something to say in favor of the double system of designating. In the first place, it combines the advantages of both. The shop needs to know only the mnemonic symbols. When the records reach the office, any clerk with a suitable cross-index table can in a few moments each day enter the corresponding numerical symbols on such records as require them. It is an advantage also to have both mnemonic symbols and numerals on records that are filed. Then the mnemonic symbols can be used for finding and the numerical for filing and thus each employed where it serves the greater convenience.

XV

WHERE TO LOCATE THE STOREROOM

TAKE a map of the United States and look at the steel city, Gary, Indiana. Why was this town located in the sand dunes south of Chicago? Primarily, a study of location strategy has indicated, because it is the economic center of ore and steel products of the United States. It is placed at the spot which is the shortest distance from the ore and coal mines on the one hand and the markets on the other.

Every factory manager has an opportunity to work out this economic problem in his own factory, no matter how small. In every plant there is a best location for materials and finished product. And this location can be determined only by studying the conditions of manufacture from the standpoint of handling materials: first, economical receipt of goods; second, economical delivery; and third, economical storage.

Too often the storeroom in the manufacturing plant is given its location because, at the time room to store material was needed, this location happened to be vacant. Without giving the matter any greater consideration the new storeroom was located in the empty space. And again, when a plant grows, the storeroom which once was located at the most efficient point may, on account of the increase in size of the factory, be not only inconvenient but absolutely wasteful in its old location. Above all, in laying out a storeroom, future growth should be considered.

An interesting case of the badly located storeroom in an overgrown plant was found in a cutlery shop. Supplies and stock which were used in the emery, buffing and polishing depart-

ments, particularly beeswax, glue and belting, were stored in a room almost as far away from the place where they were needed as it was possible to put them. When a belt broke on the high-speed polishing wheel the polisher took the old belt to the stock-room, got a new piece, went into the carpenter shop, had it patched, then returned to his department.

At the least estimate the operator on the wheel was absent twenty minutes. Generally his machine was idle for a half hour. Even if the main storeroom in this instance could not be conveniently moved it would have saved a great deal of time if a second smaller storeroom had been opened near the polishing departments where supplies intended for those departments could be dispensed.

For the uneconomical storeroom location, the manufacturer of an old mill may have a good excuse, but sometimes a man building a new factory fails to consider what is the strategic position for raw material and finished goods. A Glasgow manufacturer who builds range finders for the king's navy did consider this problem of location and solved it very neatly by placing the stock-room midway between the machine shop and the assembly room.

The assembly and machine rooms are one-story structures roofed "ridge and furrow." Between the machine and assembly shops, running the length of the factory structure, is the storeroom with a wide passage which really divides the one big saw-toothed roof area into two distinct shops except for the wide passageway in its length.

The storeroom and tool-room windows open into this passageway between the machine and erecting rooms so that the workman can obtain tools and supplies conveniently from either side of the shop. The storeroom is two stories high. In the rooms above are the testing and special small machine work. The goods are shipped from the assembly room at the point nearest the corner of the storeroom, and in this corner the finished goods are stored.

The Hendee Manufacturing Company furnishes another example of the well located storeroom. The storeroom is on the railroad side of the plant and runs parallel to the passageway which connects the several departments. Doors leading from the storeroom to each department facilitate deliveries. Openings through the wall separating the storeroom from the shop make

it possible for stock to be taken directly from the racks and fed into cut-off lathes.

Where the needs of the workmen are anticipated and deliveries are made on the order of the planning department, convenient receiving may be the prime factor in determining the location of the storeroom. The raw material and rough parts storage of the Hart-Parr Company, for instance, is handled in a two-story concrete and steel building, open to the roof at one end to permit the passage of full-sized freight cars.

Materials may be handled directly to or from any part of the floors and the siding by bridge cranes which travel the length of each floor. The track also connects with lines running to the gray iron and steel foundries. The surplus production of these is delivered on industrial flat cars to the storehouse, which thus serves as the receptacle for both inside and outside materials and supplies.

A general storekeeper is in charge, with one or two assistants, and stock is issued only on requisition of the planning department and is delivered either by flat car or truck directly to the machine in the erection department, where it will be needed.

While receipt and delivery are generally the basic elements in the storeroom location problem, this is not always so. Sometimes supplies and material are of such nature or value that special storerooms must be provided. Economical or safe storage then becomes of the utmost importance. The Jeffrey plant, for example, maintains a storeroom with a fixed temperature for the storage of automobile tires (Page 55). Because of the value of stores it also may be expedient to locate the storeroom above the first floor or in other places less accessible to burglars. Light, ventilation and fire protection are general requirements for every well located storeroom.

Economical storage also calls for a fixed minimum of investment. In those industries which are seriously affected by the seasonal demand for their product, this may be a particularly vexing problem, as facilities must be provided for an abnormally large storage for only a few months in the year. One way out of this difficulty has been found by a manufacturer of enameled ironware. Adjoining the factory he has erected tents over good substantial flooring laid on stout "horses" of sufficient height to

bring the floor up to the shipping level. When the excess storage is no longer needed the tent and floors are removed and placed in a convenient corner in the basement of the packing and shipping department.

RE-LOCATING THE OLD STOREROOM TO SERVE NEW NEEDS

IT is not necessary to build a new plant in order to find an economical location for the storeroom. By analyzing the transportation facilities, the weights and sizes to be handled, and the possible shift of departments with due respect to the building construction, an old storeroom can often be located much more efficiently.

A manufacturer who builds electric locomotives had two storerooms, one for rough stock, the other for finished goods. The rough stock warehouse was without a storekeeper. And the manager of the plant found on analyzing the layout that the stock had to be hauled on an average of two thousand feet and had to be handled about ten times. By re-arranging the inspection system and putting a storekeeper in the rough stock warehouse, the number of stock handlings was cut in two and the distance it had to be moved was reduced to five hundred feet.

If the product is of considerable weight the methods of handling it from the receiving point ought to be considered in locating the storeroom. Often, if the parts are light, it is quite possible, by a proper transportation system, to locate the storeroom cheaply with respect to building construction and at the same time reduce the amount of handling and the time spent in transferring goods.

The total of material handled in these departments and the ratio it bears to the total amount handled in the factory will often help determine the best location of the raw material storeroom and the warehouse. The central location of the warehouse in a factory making transmission machinery was determined by that plan. Instead of guessing at the location and putting a big warehouse on a railroad siding, percentage weights of material were figured and the warehouse was located where the average cost of handling by departments was least. It may often be cheaper to

shift a freight car on a spur track than to truck material up and down aisles in a factory in order to reach the stock-room.

SUBDIVIDING THE STOREROOM AND PUTTING IT ON WHEELS

ANOTHER way out of the difficulty of a storeroom badly placed with respect to the majority of the departments is to subdivide it. This can be done to advantage in the assembly room where many small parts, such as bolts, screws and flanges are fitted with larger pieces. In two or three plants this plan has been adopted successfully. Small parts are charged out of the main storeroom in sufficient quantities to fill bins in the assembly room and before these are empty the head of the assembly department requisitions new supplies from the main storeroom. In this way the advantage of having small parts where you can help yourself to them without red tape is combined with the advantage of having a check upon the quantity of such parts used.

Much space can be saved in the location of these sub-storerooms if some thought is given to the conditions of manufacture. In a brush shop, for example, many small individual boxes in which the brush is packed before it is sterilized, are stored on swinging shelves supported from the ceiling of the packing room. This not only utilizes space wasted, but prevents the disorder that usually attends individual boxing.

Portable sub-storerooms will also help out. An ordinary truck fitted with compartments and with hooks or pegs for holding different sized and different shaped pieces can be wheeled to the assembly room. For smaller work, parts stored in trays or in shallow compartments within boxes have been found to work well. Instead of distributing the small parts in bulk a definite number of trays are given out from the main storeroom.

In factories where heavier materials must be handled an overhead carrier system can often be installed which will double the efficiency of a poorly located storeroom. Between the pattern storage and the foundry in one plant the overhead trolley carrier not only reduces the time required to handle the patterns from storage to foundry but reduces the breakage. In a big electrical concern a new warehouse had to be erected in the only available

vacant spot, and this plan of bringing departments nearer the storeroom by overhead carriers instead of locating the storeroom central to all the departments was very thoroughly worked out. An overhead monorail system was installed with switch tracks leading to the different departments, so that both raw materials and finished product could quickly be distributed throughout the plant.

In building a new plant or effecting changes in the old plant so that the storeroom will be well located to serve the factory's needs, economical receipt of goods, economical delivery and economical storage then are the chief factors which will be considered in solving the storeroom location problem. A correct solution means lower costs for storekeeping, fewer production delays and greater profits.

XVI

DELIVERY METHODS THAT EXPEDITE WORK

SKILLED mechanics are expensive errand boys, yet highly paid workmen in many shops are expected to go after tools and supplies. Idle machines and production delays which they leave behind them prove an additional source of loss. And after all, to correct these evils, managers have frequently found that plain ingenuity rather than an addition to the payroll is the essential.

Toward the end of every afternoon, in a New England woodworking establishment, the storekeeper makes a round of the factory. He interviews every foreman and ascertains his special requirements for the next day. Returning to the storeroom, he fills the several requisitions and places the materials on a truck in the order of delivery. Early the next morning he repeats his round with the truck. Thus the foremen are saved sending to the storeroom except for unforeseen needs that may arise during the day. An effort is made to minimize these by keeping a comparative record of supplies so issued, and the head whose showing is poorest in this respect is due for a special interview with the superintendent. By this means carelessness in indicating the next day's requirements is largely obviated.

Routine needs of departments are met by setting standards of consumption. It is the storekeeper's duty to see that these deliveries are made regularly and in proper amount without the intervention of special requisitions. Foremen in turn see that their workmen are supplied, with the least possible interruption to production. As the men are on piecework, they can be depended upon to check any tendency of a foreman to be dilatory.

This plan has suggestions for every manufacturer who would improve his system of getting materials and supplies to the workmen. The end to be achieved is perfect anticipation of each producer's wants. So far as practicable everything that he requires should be at his elbow when he needs it. Then a minimum of his time will be wasted in supplying himself and a maximum will be available for actual production. This indicates the principle to be followed in devising delivery methods to suit the special requirements of a particular factory.

When manufacture is to stock the problem is simplest. Then the needs of every workman can be standardized and the matter of keeping him continuously supplied be reduced to a routine.

Complexity is at a maximum when manufacturing is entirely to customer's order. In this case, only by carefully planning out each job in advance can deliveries be timed so as to avoid delay and inconvenience with their all-too-frequent accompaniments—as increased operating expenses and broken promises.

Both phases of the problem present themselves to almost every manager. There are routine needs to be supplied, and special orders that require separate and detailed consideration. Even in the factory that attempts to restrict itself to stock production, there are always some special jobs, and the work of the maintenance-and-betterment department is entirely of this order. Therefore, flexibility in the delivery system is highly important. It should lend itself easily and quickly to special requirements.

Again, the method should suit the case in point of expense involved. Obviously a large factory can afford a much more elaborate service in this respect than a small one. But in any event, whatever the size of a plant, if it is large enough to justify a centralized storekeeping system, it is large enough to warrant a delivery plan that satisfies practically the criterion stated: namely, conservation of the producer's time by systematic anticipation of his needs.

Every foreman in one establishment is connected by telephone with the storeroom and telephones in his requirements. A boy attached to the storeroom then makes the delivery, taking with him a stock requisition in duplicate. The foreman, on receipt of the material, signs the original of this and retains the duplicate for his own records. For the information of the storekeeper in

holding the boy to promptness, he also indicates the time of receipt.

Where it is not feasible to operate a delivery service, or for the department heads to be connected with the storeroom, an arrangement by which the foreman sends a department clerk or general utility man for his supplies in many cases serves every purpose. This works out well if the foremen are trained to exercise the proper foresight in making up their requisitions. Spasmodic sending to the storeroom should be strictly discouraged. The plan of keeping short supply-service hours and forcing requisitions out of hours to go through an onerous routine makes for foresight.

Again, by keeping a comparative record, over a period, of the number of times daily each head sends for supplies, an effective leverage is furnished the manager by which to discourage the natural hand-to-mouth tendency.

In other instances the departmental heads have been connected with the supply and tool-rooms, particularly the latter, by means of an annunciator service. One or more messengers are then kept on duty in the room, and immediately upon receiving a bell the one free goes to the sending station indicated. He ascertains the needs, returns to the store place, secures the necessary articles and immediately delivers them. This is the plan followed at the Lodge & Shipley plant. The boys in charge of a captain line up on a bench underneath the annunciator board. This service is confined largely to tool issuance, for which it is peculiarly well adapted.

MAKING IT UNNECESSARY FOR A WORKMAN TO RUN AFTER HIS OWN SUPPLIES

TO allow, much less compel, the individual workman to fetch his own supplies is manifestly not good policy. If he is a pieceworker, he is sure to complain and if a day worker, to utilize the occasion for loafing.

On the other hand, it is equally unwise to shoulder too much of the stores-issuing burden upon the foreman. He should closely control the issuance, but be bothered as little as possible with the details. These should be handled by a clerk or other assistant.

Storeroom arrangement involves two main problems—how to build racks and bins for handy storage and how to classify and index the items. Racks and bins for special purposes are here shown. In the middle is the stock-room of the American Woodworking Machinery Company. Below is an arrangement of steel bins on sloping racks in the tool and supply vault at the Thomas B. Jeffrey plant

Methods of indexing stores are here illustrated. Above, the name of each item is painted in white on the steel rack. At the bottom, shelves may be shifted as indicated by the holes. The different sections are indicated by letter and a perpetual inventory card appears opposite each item. In the middle is a combination of open storage for large parts and numbered sections for smaller parts

A trusted workman, centrally located in the department, can often be delegated to the task. In any event, account should be kept, by individual workmen, of all supplies issued, and the foreman with aid of this record periodically should check up consumption. By this means he can hold wasteful use to a minimum.

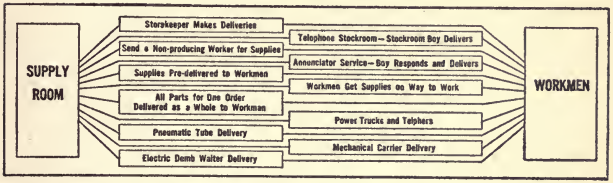


FIGURE IX: This chart suggests eleven methods of linking the factory supply room with the workman. These plans are solving the shop delivery problem in factories that vary widely in size and line

In case of such articles as files or needles, where breakage is a factor, the worker should be required to return the broken or otherwise impaired tool before receiving a new one, and the foreman for his part should be compelled to deliver these to the storeroom in exchange for a fresh supply. No extra ones should be given without full and sufficient reason.

When each man's task for the day is completely mapped out in advance and controlled from the office, an exception to this principle may be made. Then often the wise and economical procedure is precisely the reverse; the workers may advantageously get their own supplies. For instance, take a gang of shovellers. Each man on reporting in the morning should find in his compartment, in a rack near the time-clock, a slip telling him where to go, what work to do and what shovel (or other tools) to get from storage. This is the practice at the Bethlehem Steel Works with the yard men and was instituted by Frederick W. Taylor. One day the gang, or part of it, may be working on iron ore; again on pea coal or some other material. For each different weight material a special shovel is used—a long scoop for coal, a short one for ore. Thus it is necessary that the proper shovel in each case be indicated, and delivery is most conveniently accomplished by having the men singly stop at the tool storage before they go to their stations.

In case of machine attendants, on the other hand, efficiency is promoted by arranging for the delivery on the spot of all supplies and tools needed. To carry this out effectively requires at least three jobs to be planned ahead for each operator constantly. The "next" job, with its requirement of tools, all sharpened and ready for instant use, and other supplies or parts needed must be at the machine at least an hour before the job on the machine is scheduled to be finished. On the planning board in the shop at least one other job should be ready for the tools and materials required to be made up; and in the office, or planning department, a third job should be "planned" ready for issuance to the factory. This is, of course, the last word in perfection of service.

At the Hart-Parr plant an approximation to this scheme is followed in issuing work, both to the machine hands and to the erectors. In the machine shop the procedure is this: The jobs ahead of each machine are mapped out on an arrangement rack in the department operating office. When the manipulator of this rack observes that a machine shortly will be ready for the next job, he calls a move-man and sends him with the order and instruction sheet, first to the tool-room and then to the storehouse. If any special tools are required the tool-room already has been advised of the fact, at the time the instruction sheet was prepared, and it will have these ready in ample time. The move-man loads the tools and rough castings on a truck and delivers them to the proper machine. Thus, when a little later the operator finishes his present job and the foreman issues a fresh one, the tools and materials for it are already waiting.

Similarly, in the erection shop all the small parts needed for one traction engine are assembled in a wood cabinet by the finished-parts' storekeeper. The order and specifications for assembling also are placed in this cabinet. Consequently when a workman completes one job and is ready for the next, he finds everything that he needs all together in orderly array for him and almost at his elbow.

The only delay that ensues is while the recipient of a cabinet checks off the contents. The large parts, such as tractor wheels and top boards, are delivered on the spot simultaneously, or practically so, with the cabinet. Both deliveries are timed by

cooperation between the foreman and the storekeeper. The valuable time of the producer in all cases is thus conserved for the actual work of production.

DELIVERING STORES BY TRUCKS OPERATING ON A TIME SCHEDULE

IN large plants motor trucks, industrial railways, telphers and even cranes are being utilized as adjuncts of the stores department, in delivering supplies to the workmen. At the Willys-Overland plant, for instance, a fleet of motor trucks, connected with the stock-room, operates throughout the factory on regular schedule, supplying routine needs and bringing to any department special supplies as required. The foremen know almost to the minute when to expect a truck and they are prepared to place in the hands of the driver a statement of their special requirements. These are then filled on return to the storeroom and delivered on the next or second succeeding trip.

At the Ford plant motor-driven telphers are constantly on the move, reaching all parts of an immense area and furnishing to all an express delivery from the storerooms. As production is highly standardized, the requirements are almost entirely of a routine nature, and so the telphers can be dispatched and routed with practically the same precision as railroad trains.

For transmitting blueprints, specifications, samples, even small tools and supplies from a central point to all parts of a factory, pneumatic tubes have in cases proved highly efficient and economical. Some of the departments in the General Electric Company shops are thus connected. As a substitute for messenger service it is far speedier, more reliable, actually less expensive to operate and in every respect superior.

The equipment, in this instance, is limited to the handling of articles of small bulk, for which it was proportioned. But it is entirely practicable to design pneumatic carriers suitable for carrying quite large and heavy parcels. However, some type of open, mechanically propelled conveyor is in general better adapted for this purpose, and in operations where the workmen need to be supplied continuously an automatic conveyor, leading from the storage to the work places, often furnishes the perfect means.

Automobile wheels are delivered in this manner at the Ford plant. The conveyor is a simple affair; in fact, it is merely an inclined rail with a pair of guide rails above. The wheels are fed in at one end and roll down in practically a continuous stream to the point on the assembly floor where they are required.

Molding sand in a number of foundries is delivered by very much the same plan. The sand is not left on the floor from day to day, making it necessary for each molder to take an hour or more every morning to put his pile into condition. When the molds are knocked down the sand falls through gratings in the floor, is caught by a belt conveyor moving in a tunnel beneath and carried to a conditioning machine at the lower end. The output of this machine is in turn delivered to an overhead belt conveyor which automatically distributes the conditioned sand to hoppers located conveniently along the molding floor. Each molder then draws from the hopper nearest him precisely the quantity of freshly prepared sand that he requires. Such an arrangement has approximately doubled the output factor in several plants. The Kohler Company and Hart-Parr Company are two that employ it.

In another instance, for delivering tools from a tool-room on one floor to a conveniently located point in the shop on the floor below, an overhead cable conveyor has been contrived. The cable is continuous and runs between a pair of pipe rails suspended from the ceiling. The return is directly beneath the lead. At the terminal points, loading tables are arranged with finger platforms which, on the one hand, enable the carrier to pick up and on the other automatically to deposit a tray of tools. The cable turns on a pair of large pulleys, one at either end. That pulley at the delivery point is driven by belt from a nearby countershaft. By this means is overcome the handicap of a badly situated tool-vault.

Location of the storeroom often determines the method of delivery. In a small department served by a centrally located storeroom, it is about as economical to have the men come to the window for most of their supplies as it is to deliver them by boy. In any event it pays to have their work and special tools delivered on the spot.

In a large factory composed of many departments and having

one central storeroom, supplies such as waste, files, sandpaper and grinding wheels, the delivery of which cannot conveniently be anticipated, may well be distributed from the foremen's offices. This plan is almost always practical, whether or not a production or time clerk is constantly in the office, for an assistant foreman whose section of the floor is adjacent to the office can be delegated to handle the issuance.

Only a small quantity should be kept in the department offices—a week's supply at the most. In some cases a day's supply is the limit. Two reasons are given for this. In the first place, the department offices usually are crowded. And, if the storekeeper is to retain close control over issuance, the string cannot be too long.

In such cases, the routine of delivery must, of course, be altered slightly. Supplies issued for a department office are charged temporarily to the department as a whole, instead of to individual workmen or machines. The storekeeper then lays his copy of the requisition aside, marking it "Group Issuance, to Be Accounted for Later." In the department office the clerk or foreman who reissues, fills out a regular slip for each item. When the supply runs out, he clips the several record slips to his copy of the group requisition and turns them over to the storekeeper. The latter, after checking the various slips, clips them to the original copy and sends the whole to the cost department, returning the duplicate to the department official for his record. Thus to all practical intent and purpose, the routine is the same as if the workmen individually went each time to the storeroom window.

In some lines, jobs which are not completed by the end of the day furnish a complication where the material is so valuable that it must be sent to a storage vault for the night whether finished or not. Silverware manufacture is an example. At the Whiting Manufacturing Company, the management has solved the difficulty by building special racks which operate in connection with the elevator type of hand truck. These racks have a capacity of a dozen or more trays of work. During the day they are used as storage stands. Shortly before closing time all work in process is gathered into trays, and as each tray is checked, it is slid into its place in a rack. In a few minutes, a move-man

with an elevator truck takes all the racks into the vault. Next morning, just before the starting whistle blows, the department foreman opens the vault and the trucker returns the racks to their regular positions on the floor. This method insures the safety of the stock without breaking in on the time of the workmen. Formerly the trays were carried to and from the vaults by the individual workmen, at a waste of many valuable minutes at either end of the day.

So factory managers, by the exercise of ingenuity or the utilization of a common mechanical principle or device, have solved in many ways the problem of keeping the producer continuously supplied without loss of time either to himself or to his machine.

XVII

HOW MUCH STOCK TO KEEP ON HAND

PROPER regulation of the amount of stock on hand in each line and style manufactured can be determined accurately, but to do so means striking a complex equation. Storage facilities, shop conditions, investments involved, fluctuations in demand—all must be considered in obviating on the one hand shortage delays and on the other high interest and depreciation charges. Stockkeeping methods which have effectively controlled the stock at a saving in four figures have been highly developed by a concern whose annual sales run into hundreds of thousands of dollars. These methods, moreover, are so simple that even the small shop can adapt them to its needs.

When a new design has been brought out and is to be stocked, certain conditions are to be met. This design consists of several sizes of the same style, and both finished apparatus and parts are to be carried in stock. The part stock is carried partly to facilitate the shipment of repair parts, but more particularly to permit of the quick assemblage of complete machines and the economical manufacture of the parts themselves. New designs emanate from the engineering department with the consent or on the order of the sales department. If any special tools are required they prepare the drawings for them. Before any manufacturing can begin, these tools must be made.

An initial step is to assign a *piece number*. The piece number may indicate a special screw, or a single part, or a complete machine consisting of several thousand parts and costing thousands of dollars. It always identifies one object and that one only. If a customer orders a certain piece number, and a year

from now he orders it again, he will get within possible manufacturing limits an exact duplicate of what he got on his first order. The piece number is the starting point of the storekeeping and stock system.

If it seems advisable to make minor changes that do not affect the appearance or inter-changeability of the piece but which should still be taken care of as a matter of record, usually a sub-letter is added to the original number. Thus, 1192 may mean a special screw made of a special composition of bronze. This bronze may not be satisfactory for a certain use and a new composition may be worked up that has better suited characteristics. It is very desirable to know that the two screws are different in characteristics but identical in appearance and application. In this case the new screw will be known as 1192A and so carried in stock and marked. The manufacturing information will be in two parts, one calling for the old style 1192 and another calling for the new 1192A.

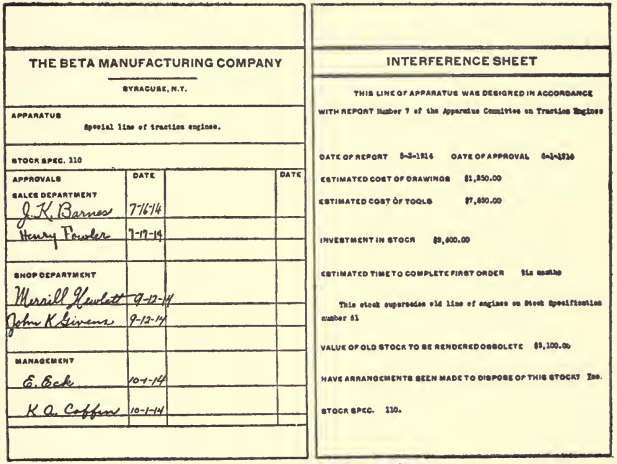
Distinct piece numbers for different styles greatly facilitate supplying the shop with manufacturing information on the various parts. Such information is called *permanent manufacturing information* (P. M. I.), as compared with that which is issued for some special order and destroyed after the part is produced. P. M. I. is filed numerically in all sections of the factory that are concerned. It is kept up to date by the engineering department, which maintains an index of all sections having a copy of such information. Revision consists in such corrections, or such changes in the shop routing or manufacturing as do not alter the final result. When the clerk in any section gets a requisition for a certain piece number he is able at once to get full information as to the part, what it is, how it should be made, and so on.

The design complete, the tools made, the piece number assigned, and the P. M. I. in the shop, all that is needed is an authority to start manufacture.

Before any competent manager will consent to an expenditure, he wants to know about it. To satisfy this natural and necessary inquisitiveness of the executive and fix the responsibility of all persons concerned, a stock specification was devised. This consists of a complete manufacturing plan for the production of

the line of apparatus described, together with the signatures of the men concerned. As pretty nearly every one in power is involved, the final document usually is a somewhat formidable one. The *stock specification* is the official confirmation that the manufacture is to start.

An examination of the various forms making up the specification will make plain the whole system. The approval sheet is



THE BETA MANUFACTURING COMPANY

SYRACUSE, N.Y.

APPARATUS

Special line of traction engines.

STOCK SPEC. 110

APPROVALS	DATE		DATE
SALES DEPARTMENT			
J. K. Barnes	7/6/14		
Henry Fowler	7-17-14		
SHOP DEPARTMENT			
Merrill Hewlett	9-12-14		
John K. Givens	9-13-14		
MANAGEMENT			
E. Eck	10-1-14		
K. A. Coffin	10-1-14		

INTERFERENCE SHEET

THIS LINE OF APPARATUS WAS DESIGNED IN ACCORDANCE WITH REPORT Number 7 of the Apparatus Committee on Traction Engines

DATE OF REPORT 5-3-1914 DATE OF APPROVAL 6-1-1914

ESTIMATED COST OF DRAWINGS $1,250.00

ESTIMATED COST OF TOOLS $7,650.00

INVESTMENT IN STOCK $9,600.00

ESTIMATED TIME TO COMPLETE FIRST ORDER Six months

This stock supersedes old line of engines on Stock Specification number 61

VALUE OF OLD STOCK TO BE RENDERED OBSOLETE $9,100.00

HAVE ARRANGEMENTS BEEN MADE TO DISPOSE OF THIS STOCK? Yes.

STOCK SPEC. 110.

FORMS XXXI and XXXII: When the manufacture of a new line of machinery is decided upon, a complete specification is prepared. The left-hand form is the first page of this set of specifications and bears the approval of various department heads. The second page (right-hand form) gives a general statement of the proposition

shown in Form XXXI. It is accompanied by the complete specification and bears the approval of the head of the sales department and whatever subordinates he feels should also sign it. The form also bears the signature of the head of the shop and such of his men as he designates. Finally it has the approval of the two vice-presidents who are in charge of manufacturing and sales, respectively.

The clerk in the engineering department who originally wrote up the specifications fills out Form XXXII. It is compiled from

information gathered by him from various sources, and the signatures on the approval sheet indicate that these statements have the assent of everyone concerned. It is especially for the information of the vice-presidents, and cannot be entirely filled in until the data on Form XXXIII is given by the sales department.

The quantity of the finished stocks, or number of the complete machines to be made and carried is indicated on Form XXXIII. The sales department is supposed to know what sales of the specified line should be. Indeed, it is only on their assurance that such a line will "take," that it is developed. The clerk fills in the piece numbers of all the different styles. From the sales department he gets data for the last two columns. The first of these is the sales department's estimate as to the minimum stock that should be carried to enable them to handle their trade, and the second their estimate of the minimum sales per month. These are, of course, merely estimates and substitutes for the more definite data that the actual sales themselves will soon furnish. They are, however, accepted as definite, and the schedule for the first production laid out accordingly, both for parts and finished materials.

HOW TO DECIDE ON QUANTITIES OF STOCK WANTED FOR NEW MACHINES

MEANWHILE, an assembling chart (Form XXXIV) has been made, showing just how many of each detail part go to make up a complete machine. This chart may be a simple sheet as shown, but more often it is a large drawing covering many styles. In some cases it may be a little book in itself, but in any event it shows the clerk just how many parts it takes to make up the desired number of machines.

Complete machines and the parts therefor, are listed on sheets as shown in Form XXXV. The clerk fills in the piece number, the description and the number of units that the sales department desires to maintain as a minimum. He then takes the document to the shop executive who will have charge of the actual manufacture. The storekeeper is also called in and together they decide on the manufacturing quantities—how large an order to enter for each of the finished machines and for all the parts.

This is a big job and one that calls for many compromises. The stock minimums are determined from the sales department's schedule. The manufacturing quantity is a compromise between a desire on the part of the shop executive to make his stuff in big lots and the determination of the storekeeper to keep his stocks down. An equitable basis is generally reached but rarely without much discussion. Discussion, however, is exactly what a complicated problem of this sort needs. Though this stock specification is as yet merely a preliminary document, it is the best arrangement that the organization can make previous to actually manufacturing and marketing the goods.

Having fixed the quantities, the stock specification clerk is in a position to fill out the interference sheet (Form XXXII). As

SALES ESTIMATE SHEET

FINISHED STOCK ONLY

PIECE	STOCK SPEC. 110	MIN. AVAILABLE	MONTHLY SALE
9160	6" x 9" Engine with condenser	12	18
9161	6" x 9" Engine without condenser	11	18
9163	7" x 10" Engine with condenser	23	18
9163			
9164			
9165			

ASSEMBLING CHART

STOCK SPEC. 110

PIECE	DESCRIPTION	Engine 9160	9161	9163	9164	9165
11616	Power plant 6" x 9"	1	1			
11616	" " 7" x 10"			1	1	
11616	" " 8" x 11"					1 1
11617	Wheels 28"	4	4			
11618	" 30"			4	4	
11619	" 32"					4 4
11620	Transmission two speed	1	1	1	1	
11621	" three "					1 1
11622	Cab large size					1 1
11623	Cab small size	1	1	1	1	
875	Boiler 30 tube	11	1			
876	Boiler 32 tube			1	1	
877	Boiler 45 tube					1 1
	Parts stock					
882	Control lever	1	1	1	1	1 1
896	Brake head	3	4	3	3	3 4
48	Ring belt and nuts	1	1	1	1	1 1

AVAILABLE SHEET STOCK SPEC. 110.

PIECE	DESCRIPTION	MIN. AVAIL.	MNFG. QUAN.
9160	6" x 9" Engine with condenser	12	30
9161	6" x 9" Engine without condenser	11	30
9162	7" x 10" Engine with condenser	23	40
9163	7" x 10" Engine without condenser	18	23
9164	8" x 11" Engine with condenser	14	50
9165			
11615			
11613			
11612			
11617			
11620			
11619			
11618			
11621			
11622			
11623			
875			
876			
877			

ABSTRACT FROM 10-1-14 TO 4-12-15 STOCK SPEC. 110

PIECE	DESCRIPTION	VALUE	SALES
9160	6" x 9" Engine with condenser	$1,150.00	10
9161	" " without "	980.00	25
9162	7" x 10" " with "	1,350.00	14
9163	7" x 10" " without "	1,150.00	88
9164	8" x 11" " with "	1,500.00	14
9165	" " without "	1,200.00	45
11614	Power plant 6" x 9"	$500.00	40
11615	" " 7" x 10"	600.00	45
11616	" " 8" - 11"	700.00	38
11617	Wheels 28"	8.00	133
11618	" 30"	9.00	171
11619	" 32"	10.00	210
11620	Transmission Two Speed	185.00	99
11621	" Three "	210.00	55

FORMS XXXIII–XXXVI: The quantity of finished stock that will be made and carried is indicated in the upper left-hand form. The lower left form shows just how many of each detail parts go to make up a complete machine. The "Available Sheet" is filled out after a conference between factory department heads. The lower right-hand form is made out at about six-month intervals and serves as a check on each stock account

soon as this is done, he is ready to get the signatures shown on Form XXXI. The whole document is made out on tough bond paper and after it is completed, blueprints are prepared and distributed to the various interested parties.

The principal copy is that which goes to the storekeeper and authorizes him to maintain the stocks at the values given thereon. He immediately opens an account with each of the piece numbers in his ledgers, as shown on Form XXXVII, and enters orders in the shop for the manufacturing quantity specified in the stock specifications. His ledger account consists of a page for each piece number and gives the information shown. It may be that on some other stock specification he is already carrying a piece that is specified anew. If so, he simply adds the manufacturing quantities and the minimum availables on the new stock specification to those that he already has and handles the account just as he would if there were but one specification with the combined quantity called for.

The ledger clerk in the storeroom office watches his accounts and, whenever the balance of stock falls to the minimum, he enters a new order for the manufacturing quantity stated. The accounts are thus running ones and unless the stock specification is changed they go on indefinitely.

To provide for a better check on each account, however, the storekeeper has an *abstract* made about six months after the specification goes into force and every six months thereafter. This abstract is taken from the ledgers by a special clerk. He makes the rounds as fast as he can. The exact time for sending through the abstracts, however, is immaterial. The general character of the abstract is shown in Form XXXVI. It gives the average monthly withdrawals for the period indicated and the name of the part and its value in factory cost. It is sent to all parties concerned, with a proposal to revise the specification in line with the consumption. If there are no dissenting voices, this is done.

The stock minimum is usually fixed at one month's stock. The manufacturing quantities based on the actual business in sight are then determined by the shop. The specification is revised, and the figures in the ledgers are changed to agree. After the revision, only minor changes are usually necessary, as the line is then probably selling at a normal rate and will do so perhaps for some years.

If it could be guaranteed that the line would remain in successful production for a long period or that the sales would very

gradually alter, the stock would take care of itself. If the sales were increasing the quantities would gradually increase and the stock would keep pace with the demand. If the sales started to fall off the stock would gradually taper off and no losses would ensue. This is an ideal condition and most lines do behave in

PIECE 9160 6" x 9" Engine with condenser FACTORY COST $1,150.00
MIN. AVAIL. 12 MFG. QUANTITY 30 STOCK SPEC. 110

RECEIPTS					WITHDRAWALS				
ORDER	NO.	DATE	DELIVERY	DATE	ORDER	NO.	DATE	STOCK	DATE
11675	30	10-5-14	10	11-15-14	X21617	2	12-1-14		
			20	11-25-14	X21618	3	12-5-14		
					X 5563	7	12-6-14		
					X21622	8	12-7-14		
11692	30	12-8-14	10	1-1-15	X21630	3	1-1-15		
			10	1-15-15	X 21700	15	2-5-15	60	
			10	1-20-15	X 21855	3	2-8-15	41	
			60			41		19	2-9-15

FORM XXXVII: An account with each piece number covering all receipts and withdrawals is opened by the storekeeper on the looseleaf ledger form shown here. Cost, minimum availablel quantity to be manufactured and specifications are also noted

that manner. When, however, a large change in the consumption of a stock occurs, loss due to overstock usually results, if sales suddenly fall, or a series of delays in delivering, if sales increase. As the system itself is based on predicting the future from the past, left to itself it would often go wrong; for business does not follow so simple a law. Hence the *abstract,* which is calculated to bring to bear the best talent for prophecy which the organization affords.

Fluctuations in the sales usually follow the introduction of a new article into the market or a change in outside conditions. In so far as the outside market is concerned, the sales force should know what is coming, and when they anticipate a change for the better or worse in the sales of a particular article,

they are bound, upon getting their copy of the abstract, to recommend that the production for the following period should be, say, fifty per cent higher than in the past or that it should be halved. And, although other departments are welcome to make their recommendations, the recommendations of the sales department are usually taken as final in this regard.

Another reason for a sudden change in the sales is the development of a new and better line by the concern itself. This usually blankets any older lines which are similar and stocks must be in shape to meet the shock. It is the engineer's place, when he has a change in mind, to issue proper instructions so that the stock may be kept down to a point where the new line will nicely replace the old.

All these features are covered in the approval of the abstract. The cost of the parts is given to emphasize the fact that stock is *real tangible money*—something that all are a little prone to forget. It also shows whether the stock is in good shape or not. If there are two hundred pieces of a certain part and the monthly consumption is ten, it is evident, as a rule, that someone has "slipped up." All hands are responsible for finding who is at fault and what is the best way out of the difficulty. If these parts are screws and the value given is twenty cents a hundred, no one will bother with it; whereas if the part in question is worth a dollar or more it is evident that any way in which this surplus stock can be disposed of will be a much welcomed money-saver.

Sometimes the sales department can make arrangements to work off this surplus by cutting the price. Indeed, the slow movement of a certain size may mean that the price for that particular size is too high. Thus the abstracts often prove of great value, if for no other reason, merely by keeping the sales department in touch with their problem.

So, too, the engineer as he looks over the abstract can see how certain idle parts or machines can be altered to make them salable. A machine may be carried in two styles of finish or paint; often refinishing or repainting where possible will "move" the stock. The engineer can sometimes see where it will pay to draw out certain idle sizes and modify them in other ways to make them active stock.

Frequently the accumulation of inactive stock can be prevented by the establishment of a storeroom for finished parts. Instead of manufacturing for finished machines, an improved stores system of manufacturing finished units for stock was developed in the plant of the Lodge & Shipley Machine Tool Company, with the result that it takes only three days from the receipt of an order to assemble and ship a lathe. As many parts have more than one specified use, the plan makes the factory much more flexible and responsive to sales demand.

For manufacturing considerations, the lathe is divided into several "groups," and each group into its component small parts. All lathes consist of similar groups and similar small parts not differing materially except in size. For example, some of the groups making up a lathe are head-stock, tail-stock, carriage, apron, and so on; some of the small parts making up the head-stock group are the spindle, driving pulley, and face gear. Each piece is given its individual piece number. Similar pieces, regardless of the size, carry the same piece number; the size of the lathe for which the piece is to be used is designated by letter. For example, B-697 is a fourteen-inch spindle; C-697 is a sixteen-inch spindle, and so on.

REDUCING THE EXPENSE OF "CHANGE-OVERS" UNDER THE STORES SYSTEM

TO manufacture for the storeroom instead of for the assembling floor is the new plan. Small parts and groups as they are completed are delivered to the storeroom. On receipt of a customer's order the necessary groups for making up the lathe called for are ordered out from the storeroom to the assembling floor.

The storeroom is divided into two sections. One section, the group store, receives assembled groups until such time as they are required for the erection of lathes. The other section, the parts store, is arranged for carrying small parts in quantities. No parts are issued from the parts store to the assembling department until all pieces necessary to finish the group on that particular order have been received.

Shop orders for lathes are subdivided into groups and each

group is brought through on an individual order. This allows the quantity of each separate piece to be varied to suit manufacturing conditions. Pieces which can be machined more economically in larger quantities than the number of the groups being brought through at that time are detached from these groups and brought through on a separate stock order. When these pieces are finished they are stored in the proper bin among the other pieces which are being brought through on the regular group order.

A tag on each bin states the piece number, the amount of the order, the date ordered, the minimum stock, and the shop order number on which the next lot is being brought through. Thus the storekeeper can see at a glance how nearly complete his parts are for a certain group without referring to his records to find in which section a piece is stored.

Similarly in the group store the orderly arrangement of the various groups on the floor makes its easy to see just what parts are on hand.

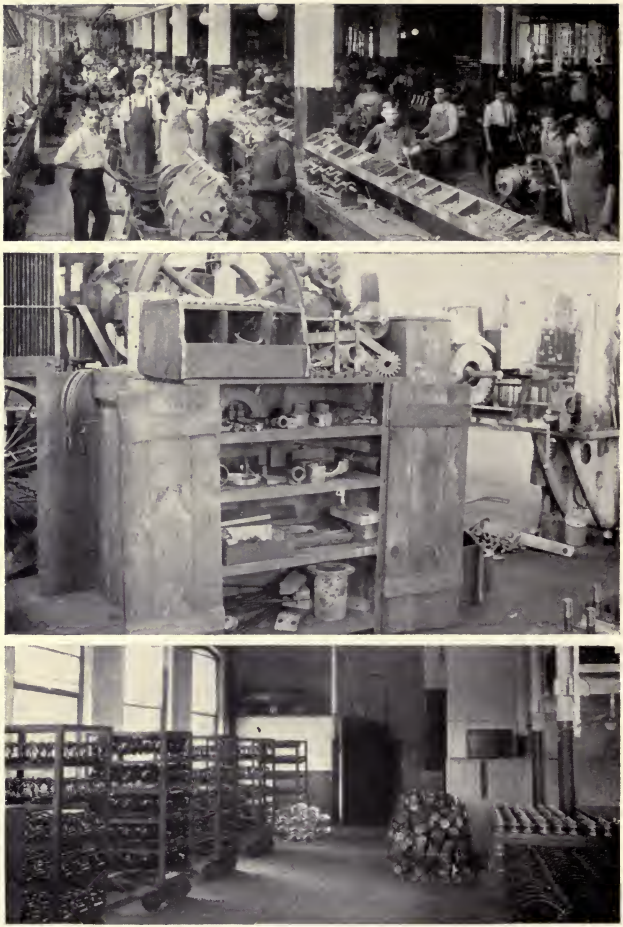
The storekeeper runs a complete card record, with a separate card for each group, showing the quantity and the shop order number. There is also a space provided for checking off additional groups received or any that may be disbursed, so that the card contains always a complete record of the exact quantity on hand.

Although economy of manufacture is not the prime object of this system, it is an important item. Under the former plan the same number of each small part was ordered as there were lathes in the finished lot. Using the parts storeroom, it is practical to manufacture certain small parts, requiring a considerable setting-up time for the machine operations, in lots of several hundred instead of fifty.

Under the stores system practically all sizes of lathes may be erected at one time; thus mixed orders can be filled promptly.

This plan has greatly reduced the expense of "change-overs." Under former conditions the firm was frequently called upon for prompt delivery of fourteen-inch by eight-foot patent head lathe, while the only finished machine on hand of that size was a fourteen-inch by eight-foot three-step cone head lathe. The stock machine then had to be "changed over" to the desired style.

The method of designating stock in the storeroom under scientific management is indicated by the index letters and metal labels respectively in these views. A unit arrangement of racks and drawers is shown in both illustrations. Long tools are stored high up in the racks to give clear headway. The arrangement in both pictures is that maintained at the Tabor Manufacturing Company



How the delivery of stores has been standardized is here shown. Small parts are arranged in racks handy to the workbench at the Cadillac Motor Car Company (top). At the Hart-Parr plant a cabinet (middle) stored with all the small parts for one machine is transported by crane to the point of assembly. Below are special trucks for delivering parts to the assemblage at another plant

The promptness with which a complete lathe can be assembled by drawing from groups in the storeroom has nearly eliminated this expense of tearing down and rebuilding a lathe which has once been completed.

Another advantage is greater promptness in handling repair orders. Repair parts can be supplied from regular stock in the storeroom. This method does not upset production as it did to rush through a single piece of one kind. An important manufacturing economy is the result. Any shortage in the store thus incurred can be remedied on the next succeeding shop order.

Moreover, the total investment in stock is considerably reduced, notwithstanding the amounts carried in the group and parts store, because there never is a large quantity of unsold lathes left over from a lot just completed and because a smaller stock of raw material is now adequate. The method thus combines flexibility with economy of investment.

Frequently, however, it is desirable to carry more stock than the present storage facilities of the plant permit. In such cases the manufacturer should not allow his storage limits to hamper him without first taking a fresh viewpoint on the stock problem. Sometimes a slight change in dimensions makes it possible to "nest" the product. Again, to handle it knocked-down multiplies storage capacity.

Because of their bulk, steel boxes recently became a problem in the assembling and stock-rooms of the plant which produced them. The process was to fold the box on a punch press, japan it and assemble. After the first fold it was difficult to handle and took up a great deal of space in the japanning oven and storeroom. Consequently, it was decided to omit the last punch press operation and to leave the steel in a long strip, which is japanned and stored until called for. A boy then assembles the box by turning the ends in a jig. It can not be formed in the press because of spoiling the coat of japan.

Simple changes such as this often solve storage problems and leave the manager free to decide his stock limits by larger considerations. In this instance the capacity of japan ovens and storage shelves was multiplied by ten, and the cost of both japanning and folding was much reduced.

XVIII

FORMS AND SYSTEMS FOR STOREKEEPING

GOOD storekeeping principles are fundamentally the same for all the various sizes and types of factories. The large shop may have a central organization, sub-storerooms, and a system based on several detailed forms. On the other hand, the manufacturer whose annual business can be measured in five figures or less, generally does not find it necessary or expedient to use such precautions and measures for the adequate control of stores. A single storeroom and a few forms perhaps answer his purpose. But the storekeeping methods of both small and large manufacturers, if their costs are being kept at rock-bottom, automatically indicate wastes, furnish comparative records of expense for supplies and materials, and guide purchasing between overstock and shortage.

The experience of manufacturers in many lines has developed some exceedingly thorough stores systems. A study of these methods was the basis upon which the Reed & Prince Manufacturing Company erected their storekeeping system, which takes care of stores of every sort and is widely applicable. How this system operates is told in Mr. Reed's own words.

Our system of handling stores [says Mr. Reed] keeps account of all the raw materials that are needed in the manufacture of our regular products—wood screws, rivets, bolts, machine screws and so on, and all the supplies necessary for the manfacture of these classes of goods. Moreover, it has enabled the purchasing department to keep in close touch with the stores department and has so centralized records and materials that one clerk can look after the work.

The stock carried by the storeroom includes raw material, wire and rods; the tools necessary for forming the raw material into finished product, and packages and labels for preparing the product for shipment. It is necessary also to keep repair parts on hand for machinery which is used throughout the factory and other supplies which are necessary to keep the whole plant in running order. To sum up, in our factory the stores department handles all the necessary materials from raw material and coal to stationery and office appliances.

No part of the accounting is done in the storeroom except the handling of requisitions for goods delivered and the slips for goods received. It is possible, by keeping track of the relation between goods delivered and goods received in the purchasing department office, to keep the necessary purchases to the minimum limit at all times so that the amount invested in stores and other material is right. Moreover, the records, as will be pointed out in the subsequent pages, are so arranged that they are available for future reference. It is always possible to tell how much of any particular item to purchase or to have made in the factory. This simplifies the work for the purchasing department. In most cases it is only necessary to state the standard quantities which are to be purchased and the purpose for which the article is used. The detail work of ordering is done by a competent clerk in our purchasing department.

To install this system a list was first made of every article that was to be kept in stock. This is a fundamental proceeding for a storeroom system. Without the list little can be accomplished. Properly classified it forms the basis for correct ordering.

The second step necessary in working up a stores system is to arrange a set of books of account for such articles as are received and distributed. There are three sets of these books in our offices. The stock account books (Set I) consists of a series of looseleaf books (Form XXXVIII), in which daily entries are made, showing how much stock has been ordered, how much received and what has been delivered out of stock each day. The weekly stores report (Set II) shows the amount of each stock article on hand at the end of each week. This also is kept in a looseleaf ledger (Form XXXIX). The depleted stock list (Set III) is a tabulation (Form XL) of the condition of items run-

ning short. From it new orders are made out, and old orders are hurried when necessary.

In addition to the three sets of books described, a reference book is made up for the purchasing agent, which contains a duplicate of the stock list. In this book is recorded the amount of each

Maximum 20,000 lbs. .400 BASIC WIRE Minimum 5,000 lbs.

Order	Requisitions				Deliveries				Requisitions				Deliveries			
	Order No.	Amt.	Rec'd	Bal. Due	Amt.	Dept.	Cost	Bal. on Hand	Date	Order No'	Amt.	Rec'd	Bal. Due	Amt.	Dept.	Cost	Bal. on Hand

Weekly Stores Report

Index No.	Name of Part	Minimum Quantity	Week Ending												Quarterly Total	Weekly Average
	400 BASIC WIRE	5000#														

List of Depleted Stock — Week Ending

Name	Index No.	Minimum	On Hand	Due	Order No.
Punch Cam	052	3	2	10	052
Sleeve Cam	053	10	8	20	053

FORMS XXXVIII-XL: All these records are handled in the factory office by one clerk. From them the purchasing agent keeps accurate account of all raw material used in the factory. The records are simplified and compact

stock article used during each quarter with a space for recording the total amount used each year. This books shows the purchasing agent the condition of all regular stores and also enables him to compare the stock used in different quarters by periods.

The book sets, Nos. 1, 2 and 3, and the additional reference book just described enable the purchasing agent not only to keep an accurate account of all the regular supplies, but to check misuse of supplies and to control closely the purchasing of materials and supplies.

KEEPING TRACK OF MATERIALS, SUPPLIES AND TOOLS BY DEPARTMENTS

TO keep track of the raw material, tools and miscellaneous supplies which are used in the factory is the next step in handling the system. The basic stock list to which reference has been made, is divided so that every section is a list of the articles used in one department.

The foreman of every department is provided with a list which shows what stock is carried for his purposes in the storeroom. In listing this stock the tools and miscellaneous supplies are tabulated according to their names, but in case of repair parts it has been necessary to list by number. Consequently, in order that a foreman may specifically and accurately know repair parts, each department head is given an alphabetical list of the repair parts for his department which are carried in the storeroom, together with their index numbers.

The storeroom is provided with a numerical list of these parts, which gives the name and location of each. Every part has a

Date Jan. 11, 1915	Stores Requisition		For Dept. Machine	
	Items Wanted	Bin		
3 pr.	1x8 F. H. W. S. Dies	K - 3		
Ordered by Kane		Delivered H. A.	B.	
For Order No. 736 A				

FORM XLI: Simplicity marks this stores requisition. All the important items are covered and ample space is provided for each and also for any notations the stock clerk may find necessary. The slip is standardized in size for filing purposes

definite place in the storeroom so that it can readily be found by the storekeeper.

When a foreman wants material of any sort from the storeroom he specifies the articles on store requisition slips by name or number as provided for in his lists. He then sends these requisition slips (Form XLI) to the storeroom and the material or parts are delivered.

When the stores clerk makes the entry in the stores account books, the cost of the material delivered is recorded on the requisition. Requisitions are filed behind tabbed cards arranged according to departments.

In making out the requisition the foreman must be careful to

list accurately just what material or repair parts he wishes. The stores clerk has orders to check very carefully all foremen's requisitions so that the records will call for items listed exactly as they are in the regular list of stores kept on hand. This avoids confusion in tabulating the records of disbursements and standardizes to a great degree the work of purchasing. If the articles ordered by the foreman are not specified properly, corrections are made on the slips by the stores clerk so that there will be no mistakes when the slips are entered on the stores account books.

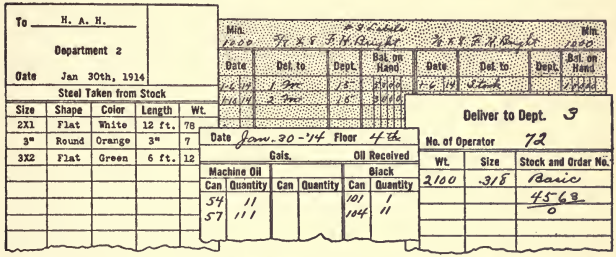
That a close check may be maintained upon the amount of stores used by each department, every week the stores clerk makes out a condensed report. There are three regular items which every department in the factory uses. In some departments the subject of the expense account varies, and it is advisable to change the headings of the columns shown to meet these different requirements. As the average expense account has been determined for ordinary conditions, these weekly storeroom reports make it easy to watch for extraordinary charges which may need investigation. In making up this storeroom report the requisitions which are sent from all departments by the foremen are grouped according to the headings on the storeroom report sheet and the expense recorded in the proper column.

HOW A COLOR SCHEME SAVES TIME IN HANDLING STOCK

RAW material, tool steel and machinery steel are kept track of by approximately the same record system as the other regular stock. The sizes and kinds of steel are listed and divided into two accounts—tool steel and machinery steel. The quantities of steel are tabulated under these heads according to the shape—round, square, or flat. A daily inventory is kept of the size, shape, length, and weight of steel taken from stock for the various departments. This record comes each day to the stores clerk on a card (Form XLII). From this record the details are tabulated in the looseleaf, stock account book.

To save time lost in handling short lengths of stock, the bars of steel are striped the whole length in a color to indicate the purpose for which the steel is used. If only a section or one

end of a bar were striped, the length remaining after any machine operation which removed the stripe would likely be confused with short lengths of different compositions. The column headed "Color," therefore, indicates the kind of steel: self-hardening steel is painted red; header dies, white; r. t. dies,


To H. A. H.
Department 2
Date Jan 30th, 1914
Steel Taken from Stock

Size	Shape	Color	Length	Wt.
2X1	Flat	White	12 ft.	78
3"	Round	Orange	3"	7
3X2	Flat	Green	6 ft.	12

Min. 1000
Date | Del. to | Dept. | Bal. on Hand
1/6/14 | 1 Tool | 15 | 2000
1/14/14 | 2 Tool | 16 | 3000

Min. 1000
Date | Del. to | Dept. | Bal. on Hand
1-6-14 | 2 Tool | 15 | 2000

Deliver to Dept. 3
Date Jan. 30-'14 Floor 4th
No. of Operator 72

Gals. Machine Oil				Gals. Oil Received Black	
Can	Quantity	Can	Quantity	Can	Quantity
54	11			101	1
57	111			104	11

Wt.	Size	Stock and Order No.
2100	.318	Basic
		45-62
		0

FORMS XLII-XLV: At the left is a steel stores report. Requisitions for oil and raw stock are illustrated at the bottom (center and right); and a stock record of office and stationery supplies is shown in the form at the top (right). This stock record is kept hanging at the end of the shelves

green; cutting tools, w. s. cutters, hobbs, shaver cutters, formed cutters and c. t. dies, orange; crucible steel and low grade steel, blue; machinery steel, yellow. This saves a great deal of material otherwise wasted.

The raw material which is kept in stock—wire, nuts, rods and burr plates—is piled up in sections allotted every size and kind. Operators using this material requisition it on slips provided for that purpose (Form XLIII), showing the kind, amount, and size of wire needed. The weights of the wire delivered are recorded on these slips, and from them entries are made into the stock account books, showing the amounts which have been taken from stock.

For handling the oil, a tank is installed on every floor of the factory. Each tank contains a barrel of the several grades of oil used in the departments on that floor. These tanks are filled whenever necessary, and oil is requested on the regular stores requisitions.

For keeping a detailed account of the oil, cards are delivered on each floor, to the foreman's clerk who has charge of the oil tank. When any can is filled the kind of oil taken and the

number of the can are recorded on one of these slips (Form XLIV) so that it is possible to tell where oil is used. Records are made from these cards showing the amount of every kind of oil on each floor per week.

For some articles which are carried in stock individual accounting in the weekly stores report would be cumbersome. This is true of machine screws and labels. For this purpose ordinary ledger-ruled, three-by-five cards are used (Form XLV), and each card is considered sufficient for two sizes of labels or machine screws.

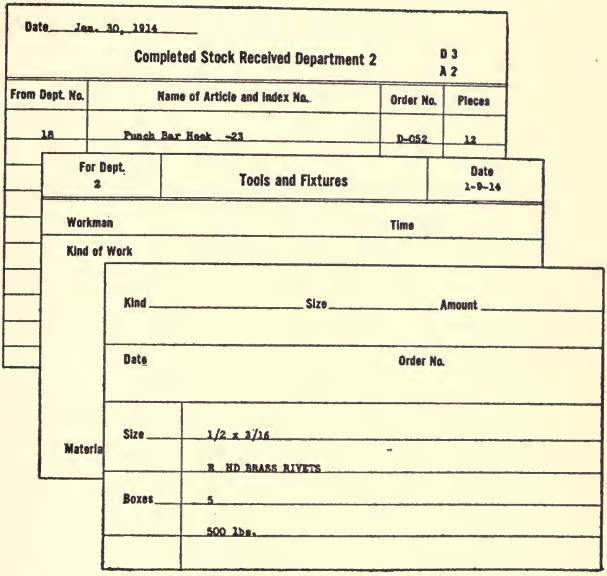
In order that new material can be ordered in ample time, the stores clerk reports such of these articles as are below the minimum limit. Requisitions for these two items are sent into the storeroom the same as for other articles, but the records are kept as simple as possible on the cards instead of in the stock account books.

Goods which are made in the factory and delivered to the storeroom for regular stock are ordered on what are known as tools and fixtures slips (Form XLVII). These orders are made out in triplicate from the depleted stock list and two copies are given to the department in which the goods are made; the third copy is kept in the storeroom for reference. As soon as these orders are written, entries are made in the stock account books showing what has been ordered, the amount, order number and date. These order numbers, in the case of tools, are used for convenience in locating the order and keeping track of it in process. The number itself has no particular reference to the kind of tools which are being made. In the case of repair parts, however, the order number and the index number are identical.

Orders for *special* tools and fixtures are made out on tools and fixtures slips the same as those for regular goods, with the exception that they are stamped "special." These special items are listed on sheets and each department has a separate sheet for special goods which it is asked for. On these sheets the order is described; and the date of receipt, number of the order, date of delivery, number of pieces and the cost are tabulated. By this means an account is kept of the expense of special tools and fixtures, and it is a simple matter to distribute this report to the various departments, so that they can at once advise whether or

not to adopt some of these special items as regular stock. This record shows also whether the foreman has used good judgment in getting out his specifications.

In checking deliveries of goods received each day in the storeroom, for which the tools and fixtures slips call, a special record



Date Jan. 30, 1914

Completed Stock Received Department 2 — D 3 / A 2

From Dept. No.	Name of Article and Index No.	Order No.	Pieces
18	Punch Bar Hook -23	D-052	12

For Dept. 2 — Tools and Fixtures — Date 1-9-14

Workman — Time

Kind of Work

Kind _____ Size _____ Amount _____

Date — Order No.

Materia

Size 1/2 x 1/16

R HD BRASS RIVETS

Boxes 5

500 lbs.

FORMS XLVI–XLVIII: In the middle is shown a shop order for tools and fixtures for "home" consumption. At the back is a record that helps check deliveries. By filing these slips (front) as described, minimum and maximum stock quantities can be conveniently fixed for the factory

like that shown in Form XLVI has been found valuable. Care must be used to see that the names of the articles received correspond exactly with the classification on the tools and fixtures slips, in order that no mistakes are made in entering these items in the stock account books.

For following up these tools and fixtures orders a copy of every order is kept in the storeroom in a file arranged so

that each day goods which are due come up. The department filling these orders is then reminded of what it promised. In cases when goods cannot be delivered on schedule, a new promise is obtained, and the department which is waiting for the outside material is advised of the delay and the new date of delivery. This plan affords accuracy in follow-up methods.

In order to keep track of the orders received in the storeroom from the various departments, the tools and fixtures slips are classified under five different heads:

1. Orders for regular tools.
2. Special tools and repairs.
3. Steel repair parts.
4. Casting repair parts.
5. Tab cards showing the dates of the month.

In the first class, regular tools, the orders are arranged according to the different kinds of tools, and these are subdivided into groups by tab cards. Special tool orders are arranged according to departments and these groups of department cards are separated by tab cards. Regular repair parts are grouped in the file according to order numbers. This order number is identical with the index number of the repair part itself. Orders for special repair parts are filed according to the department for which they are made. These are placed with the orders for special tools.

Promises are given to the stores department as to the date on which each of these orders will be completed; and this date is written on the order itself. Besides this, a slip of paper is made out bearing the order number and the department for which the goods are intended. This slip is put behind the proper date card in the follow-up file. If it is necessary to make out a new date on which the order will be finished, this slip can then be filed ahead and the new date entered on the original order kept in the file.

If interruption to production through delay in the delivery of supplies is to be avoided, definite relations must exist between orders and stores. This relation is maintained by means of information furnished by the order department for the amount of raw material used for each order issued to the factory. As wire, wire rods and rivets are the principal items of expense, slips are furnished by the order department, which show the

sizes, kinds and amounts used for each order (Form XLVIII).

A set of tab cards, each marked with stock sizes of wire and rods, are used for this purpose. Behind each of these tabs are filed the slips furnished by the order department, which show the kind of wire and the amount that is to be used for every order. By filing these slips back of their respective tabs, it is possible at any time to tell the amount of wire necessary to fill such orders as are in the factory. When these orders are completed they are returned to the stock clerk, and the slips which have been filed are taken out and destroyed, as the factory order is returned to the order department for filing.

To make this system for handling details effective, the duties of the storekeeper and the stock clerk are classified. To cut out unnecessary labor and lost time in their respective departments their time can profitably be distributed to their jobs. Definite printed instructions are issued to both the stock clerk and the storekeeper.

It is the duty of the storekeeper to see that the stock in the storeroom is kept in good order, that it is properly arranged and that each item is given a definite place so that it can be found without delays in the delivery of articles distributed from that department.

By means of the depleted stock list, the storekeeper can closely follow those items which are low in stock and those which are needed the most, and can issue instructions to the various departments making such goods as are needed and as are called for by tools and fixtures orders.

The storekeeper further keeps track of all orders for tools and fixtures and various goods made in the factory which are distributed from the storeroom, including the regular stock of repairs, and tools and special items. He also makes out records for these items as they are received on various orders, so that they can be listed properly in the books and a correct account made of what is delivered to the storeroom. The regular stores requisitions are gone over each day to see that they are properly made out. This is essential because it eliminates errors in classifying totals in the stock account books.

Similarly the duties of the stock clerk are classified and scheduled so that he can perform his work with the least friction.

The first period of each morning is spent in entering in the stock books such articles as have been received in the factory and storeroom during the previous day, and in making entries of those orders that have been made out for new stock material.

During the second period, entries of all goods delivered from the storeroom are made in the books, including raw material, repair parts and other supplies.

On Monday afternoon, records are made from the stock account books into the weekly stores report book, which show the amount of each stock article on hand at the close of the preceding Saturday.

On Tuesday afternoon, records are made against each article on the depleted stock lists showing the balance due on goods which are below the minimum amount.

Wednesday afternoon is occupied in making out a statement of the oil used by each department during the preceding week and in listing it in standard quantities with the cost.

Thursday afternoon is devoted to making out a complete report of all stores used by each department during the preceding week so as to show the total expense of the goods supplied to the several departments by the storeroom.

On Saturday afternoon work which has come in during the week is adjusted and special reports as they are asked for are made out. Figures are computed giving the weekly consumption of every stock article.

A SHORT-CUT SYSTEM FOR CHECKING LEAKS IN HANDLING STORES

A SIMPLE and effective system for handling stores with important variations from the foregoing plan has been evolved by a manufacturer of brushes. It acts both as a check on leaks and as a basis for distributing general expense.

All general stores are kept in a storeroom, from which withdrawals are made only on the presentation of the usual requisition. This card is sent to the cost department after the supplies have been delivered. The head of the department for which the supplies were ordered keeps a duplicate copy.

On the card are scheduled the date, name of department

receiving the supplies, by whom delivered and received, and a space for clerical checking, in addition to columns for quantity, name of article, price and value. Each of these spaces is significant.

The unusual feature about this little stores system is the foreman's report, which has been found very useful. It is made

Shortage Report **Date**

Drwg. No.	Name	Amount Short	Date Short	Amount in Stock	Mfg. Order	Amount of Order	Dept. Located	Amount in Dept.	Remarks

Storekeeper _____ Order Clerk _____ Production Clerk _____

Record Clerk _____ Tracing Clerk _____ Production Manager _____

FORM XLIX: Twice a week, in an Illinois factory, the shortage report shown brings this item to the attention of the manager. Spaces are left for the initials or signatures of six employees whose business it is to prevent shortage. The resulting teamwork successfully forestalls any serious lack of materials or supplies

out in the office and is sent to the department foremen at the end of each month. Thus it gives each foreman a chance to know with what he has been charged.

On the front of the card is the name of the department and the month, together with a summary in dollars and cents of the direct labor, material, repairs and supplies which were charged to the department for the month.

Below this summary are figured in percentages, the rates of the current indirect labor and supplies to direct labor, together with similar percentages for the preceding month and for the month in which this percentage was lowest.

To sum up, this supply record gives an idea of what the labor, supply and material, and repair expenses of each department are. By this means only can an accurate percentage cost be found. Also it makes the foreman responsible for his general expenses. This has a healthy influence in checking leaks. If a man knows that his general expense is being totaled in the office he will be more careful in his expenditures. General stores

will be used more economically, and tools and supplies will be made to wear longer. Segregating stores also makes it possible to keep a perpetual inventory—to credit and debit stock as it is used.

To prevent shortages is particularly the object of every well-planned stores system. The manager of an Illinois electric plant has met this problem in a simple way.

The trouble with shortages had been a frequent occurrence. One day the foreman of the assembling department called the manager by telephone and wanted to know why the storeroom did not deliver some material. The shortage, he said, dated back two weeks or more. Calling for the stock card, the manager found the material quoted as in stock. When the storekeeper was asked if this were true, he said that he thought so. Investigation, however, showed that the item was not in stock and that an order had never been placed to remedy the shortage. No explanation appeared, other than neglect.

Within two days the same assembling foreman called for another item. Again there was a shortage which the stock card did not show. As the item had been short over two weeks and an order had been placed, it was apparent that the follow-up was at fault. On investigation, it was found that the item, after the first notice on the day of the shortage, had been completely forgotten.

At this point the manager determined to put a check upon all shortages and their follow-up. He would want to know the date of shortage, piece number, name and quantity short. In order to get action on the report, he would need to know whether the parts were in stock and not delivered from the storeroom; whether a manufacturing order had been placed to remedy the shortage, and if so, its schedule, so that he could telephone the proper department regarding its completion. These points were accordingly embodied in a handy report (Form XLIX).

Every Monday and Thursday the storekeeper makes out this report, filling in the drawing number, name, amount of shortage and date short. The report must include every actual shortage in the storeroom. Next in line the record clerk checks these shortages with his stock cards, indicating any disagreement. An unrecorded shortage looks bad for the storekeeper.

As the report passes to the order clerk, he fills in the order number and quantity covering the manufacture to replenish each shortage. The tracing clerk then takes the report and locates the material in process, indicating the department occupied with it and the amount available. Finally, the report comes to the manager, with all the information he needs to rush the material forward by telephone.

Under this plan everyone concerned goes on record before the manager regularly. As anything that is in error comes directly to the attention of the chief, the storekeeper watches shortages persistently. The production clerk feels that to have an item appear on this report more than once seriously reflects on his ability to watch the stock. The record clerk is more careful of his entries and calculations. The order clerk does not want to be found with a shortage not covered by a manufacturing order. The tracing clerk dislikes to go on record as behindhand or in error. Finally, the production manager feels responsible for a clean bill in all of his departments. A moral force is exerted to keep the report favorable all the time.

XIX

HOW INVENTORIES ARE HANDLED IN TEN PLANTS

INVENTORY means overtime and wasted effort in the average factory. The responsibility for the work is given to one man who gets the job out as best he can; the bookkeeper works overtime trying to adjust a complicated array of facts and figures to fit a price list; men are laid off in the manufacturing departments for a period, and when the checking is finished there is still a liability of error.

To simplify matters, to record all material quickly and accurately, and to keep the workmen in the production departments idle a minimum time, one machine company instituted the following method:

The principal feature is that in arriving at the final result, nothing has to be copied; nothing is put down a second time. This eliminates many chances for errors. The grand total value, which is the figure wanted regardless of detail—detail can wait—is obtained at the earliest possible moment. Since cards and loose sheets are used, the work can be distributed among many clerks and a number of adding machines can be used.

Each job is specialized. One man prices; one man checks prices; a number of men extend by hand; and one man checks the extensions with a calculating machine. In pricing and checking extensions, a great deal of time is saved by having the inventory tags sorted by commodities. The sorting must be made eventually; it had better be done the very first thing. There is nothing complicated about any of this work. It is simple; and yet everything which can be used is recorded.

Organization is essential; everything is planned beforehand

Compactness, ventilation, convenience, light and safety from fire are among the points illustrated in this view of the stock and tool department of the Cincinnati Milling Machine Company. A classification is shown by the index numbers on the ends of the cabinets. The second tier of racks is raised so as to allow the stock-keeper easier access to the first tier and permanent ladders are provided opposite each rack

In maintaining a perpetual inventory, records are ordinarily kept close to materials and supplies. Card files are placed for easy reference in the stores department shown at the top. Under each bin is a slide for cards. It has a rough surface so that it can be chalked. Below, in a tool and supply vault, steel cabinets are used for safekeeping of the records of the cost department

in readiness for inventorying. Each foreman is given a chart of the personnel so that he may know whom to call upon for assistance. He turns in the names of the workmen who will help him to the office manager, who criticises the number of men wanted, their rates of pay for the work, and so on.

(1) 19 **INVENTORY TAG**

TAG NO. 1 | CATALOGUE NUMBER 2 | LETTER 3

DATE 4 DEPT. NO. 5 BLDG. 6 FLOOR 7 ALLEY 8 BIN 9

NAME 10

KIND OF MATERIAL 11

SIZE OF MATERIAL 12

CONDITION (LAST OPERATION) 13

CALCULATIONS		QUANTITY UNIT	QUANTITY AMOUNT	PRICE	PER	VALUE
PIECES 14	GROSS 18	PIECES	20	27	28	32
POUNDS 15	TARE 19	POUNDS (NET)	21			
WT. PER PIECE 16		FEET	22			
PCS. PER LB. 17		23	24			
COUNTED BY 25	CHECKED BY 26					
PRICED BY 30	CHECKED BY 31	LABOR	29		100 PIECES	33
EXTENDED BY 34	CHECKED BY 35					

P. S. ALL CARDS MUST BE ACCOUNTED FOR

FORM L: In order to prevent inaccuracies and omissions, the management issues a set of instructions numbered to correspond exactly with the numbering of the spaces as shown. What is to be written into each space is explained in complete detail. A specimen card, of course, is attached to each copy of the instructions

To facilitate the work, the office manager has three representatives to look after the detail of the work in the factory:

Head Storekeeper—Raw Materials.

Production Man—Work in Process.

Stock Record Man—Finished Machines, Attachments and Repair Parts.

They see that the inventory is made according to the instructions which the general superintendent issues to every foreman two weeks before the beginning of the listing. Any matters about which there is question are taken up with the office representatives and, if necessary, they refer the matter to the office manager for his decision.

Each foreman is held strictly responsible for the accuracy of the work in his department, and is required to sign and send

in with the inventory tags a certificate in the following terms:

"I hereby certify that the inventory of machines and parts thereof, finished and in process, and all merchandise, materials and supplies on hand in the.....Department No.....as shown on tags No.....to...., has been carefully and accurately taken by actual count, weight, or measurement, and that all obsolete, damaged, or depreciated items are specially noted."

The inventory tags (Form L) are charged by numbers to the department to which they are issued. Every tag given out must be accounted for when the inventory has been completed and the tags turned in with the certificate. If, for any reason, a tag has been spoiled, a notation to that effect is made and both the original and duplicate are sent to the office with the balance of the inventory tags, all of which are sorted in regular numerical order (small numbers on top).

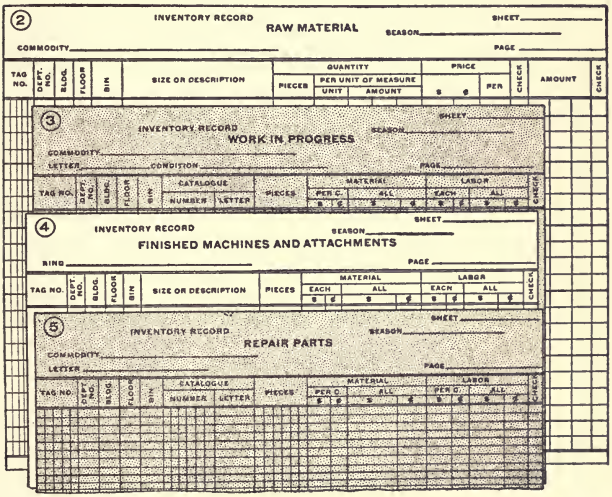
All articles which during the season are regularly procured from the storeroom are sorted and counted by the different foremen; and the count (on a regular shipping tag) attached to the boxes or other receptacles containing the articles is sent to the general stores department to be included in the stores inventory.

The inventory is taken by actual count, weight or measurement, or weight and count, as the commodity may demand. Where weighing or counting is not practicable, estimates are made, but only by written permission of the office manager, and in the presence of him or one of his office representatives.

In recording raw materials and supplies great care is taken that the *trade unit of measure* is used in showing quantities on hand. To secure the correct labor value of all work in progress, the catalog number, name of each part, and the last operation performed are listed, and in unfinished work, where operations have been performed out of the regular order, all operations which have been performed must be shown. On the other hand finished machines and attachments are reported by the number which they bear. Finished attachments in the warehouses which are in a "knocked down" state are noted by the assembled part numbers and names according to the material lists. Attachments already packed are inventoried by the shipping package name and number (Forms LI-LIV).

In sorting and counting, old stock is placed in such a way that it will be used up at the beginning of the next season. Merchandise, materials and supplies which are unsalable or damaged, or have depreciated in value, are so designated on the inventory tag. The approximate per cent of depreciation is also stated. As far as possible, disposition is made before inventory, of all obsolete material or machine parts. Any such stock which may remain must be fully described on inventory tags so that it will be cleared shortly.

Special attention is paid to all stock located on platforms, bridges and other places outside of buildings, in order that



FORMS LI–LIV: These sheets, which are distributed among the clerks, make inventory taking a matter of days instead of weeks. By separating the materials or work handled, plans can be mapped out for four distinct departments

omissions or duplications may not occur through misunderstanding as to ownership. Foremen of adjoining departments confer regarding such material, and in the presence of one of the office representatives decide who will inventory the material in question.

While inventory is being taken, no stock is moved in a department except upon the written approval of the office manager. Stock, however, may be transferred between two departments prior to the taking of either of their inventories, or after both

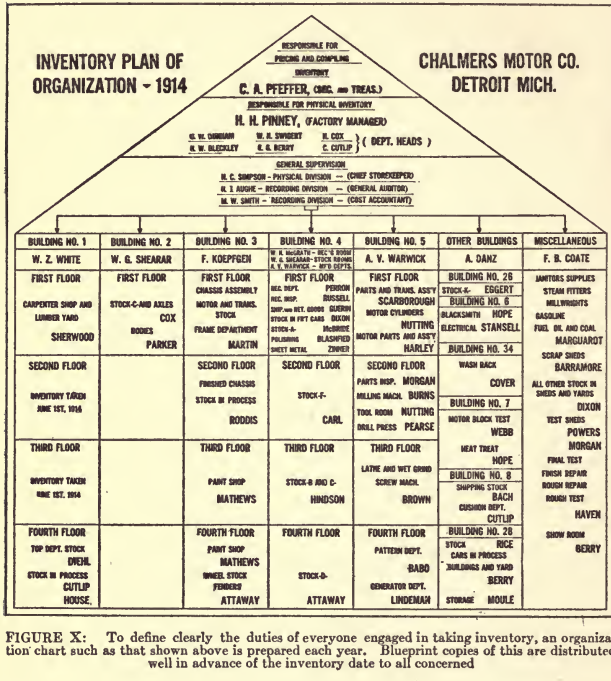


FIGURE X: To define clearly the duties of everyone engaged in taking inventory, an organization chart such as that shown above is prepared each year. Blueprint copies of this are distributed well in advance of the inventory date to all concerned

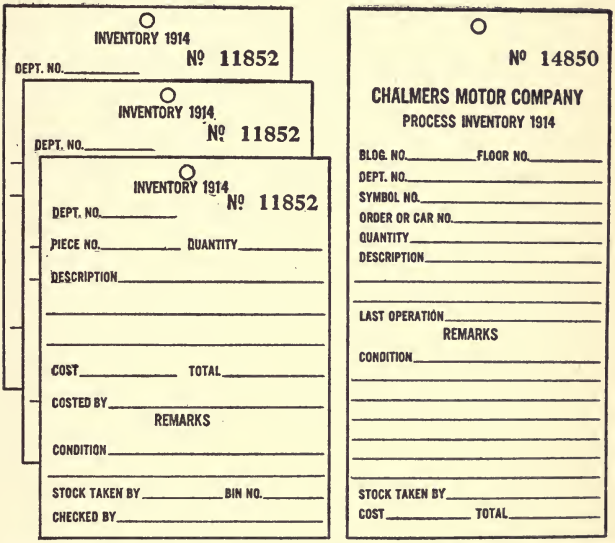
have been completed. The shipping and repair departments arrange beforehand for all stock likely to be required during the inventory period, which is ordinarily two weeks.

All material received at the works after the listing has begun, even though previously invoiced, is not included in the season's inventory but is stamped, "Not Inventoried." All material received at the works prior to inventory date, however, is in-

cluded in the inventory, and the invoices for such material are stamped, "Inventoried." Any material received prior to the date of inventory, but not unloaded, is included in the inventory.

All shipments of machines, repair parts and materials, subsequent to the date of inventory and prior to the completion thereof, are, of course, included in the inventory.

Tags are attached to all objects as inventoried. No tags are removed until everything in a room has been considered. The inventory tag is in duplicate. The department foreman and the



FORMS LV and LVI: Two weeks in advance of the inventory, clerks attach triplicate tags (shown at left) to all stationary stock At that time the description is filled in, on the uppermost ticket only. The duplicate and triplicate are used on inventory day. For goods in process the manila tag at the right is used. It is attached the day previous to inventory

office representative, before collecting a single tag, make a very careful trip through the department to make sure that everything which should be inventoried in the department has an inventory tag on it. Together they collect the inventory tags, leaving,

if they so desire, the original or blue tag attached to the stock. The card (white part of tag) is sent to the cost department. They check the description, catalog number, quantity, and so on, to the best of their ability. After the tags have been collected they are arranged in numerical order with small numbers on top, including all of the tags which may have been marked "void" or "spoiled." The last tag is plainly marked, "Last tag No. ——," showing the number of the last tag used. All the tags delivered to the department, including unused tags, are sent to the cost department with the certificate.

After the tags have been returned to the office and all the numbers accounted for, they are sent to the printers and cut at the dotted line. The blue part is returned to the shop for the files and the cards, which are then standard size, five inches by eight inches, are returned to the cost department.

Commodities are sorted first and then priced. As soon as they are extended and checked, the amounts are listed with an adding machine, making sub-totals for the various kinds, sizes or classes of each commodity. A recapitulation of these totals is then made according to the various accounts carried in the stores ledger.

After the grand total value of the inventory is ascertained, the balance of the information required on the summary sheets is filled in from the cards with ink. The sheets are then arranged in proper order and sent to the printer to be bound with a light cover and stapled. The cards are filed away in the vault in the place previously occupied by the cards of the second preceding year.

HOW ONE COMPANY SAVED TEN DAYS IN TAKING AN INVENTORY

TWO weeks was required for this inventory. Methods of inventory, however, vary as widely as factory conditions. The less the time for inventory, the less will be the contingent interruption to production and the overhead per unit of output.

Two years ago a manufacturing plant in Cleveland was shut down for a fortnight while its employees were taking the annual stock inventory. Last year the same force of laborers

with the assistance of an appraisal company did the same work in four days. With the expenditure of less than two hundred dollars the manufacturing company was able to make a saving of ten days. The appraisal company was represented in the plant by just one man and the actual work was done by the same employees who had handled it the year previous. A comparison of the methods used in the two years will explain, however, the great difference in time.

That the foreman of each department and the men under him best knew the material in that department was the belief of the company. They believed, therefore, that the foreman was best suited to take the complete inventory of his department. The appraisal company thought differently; it divided the work so that the foreman of a certain department, such as the press-room, went through the entire plant with a selected group of men, taking his own special line and nothing else.

After all the material was listed, it was checked by the appraiser and the foreman of the department in which it was found. It was then priced but by a new method. A schedule of all the different parts used in making up the manufactured product was prepared. From the company's cost records a schedule of each different operation in the manufacture of each part was drawn up. The use of these figures did away with the possibility of wrong or inconsistent prices such as were found in the inventories of previous years.

Above all, inventory should be thorough and taken in the minimum possible time. The Chalmers Motor Company inventory meets these requirements by methods which differ from those previously discussed (Figure X). Factory operation is interrupted ordinarily for inventory only one day. If the date falls on Sunday or a holiday, work is not suspended at all. The one-day inventory has been made possible by thorough preparation. Two weeks before the actual listing and counting, clerks begin the tagging of all stationary stock. The inventory tag (Form LV) is in triplicate. The clerks fill in a description of the stock on the uppermost (yellow) ticket. This is then detached and sent to the office, where it is priced by the cost department. The pink duplicate and manila triplicate are not removed until the day of the inventory.

The first step then is to ascertain and fill in the actual quantities on the pink slips. As soon as these are entered, the slips are detached and returned to the office. The accounting force now matches them with the yellow slips previously sent in, enters on the yellow slips the quantity as designated on the pink slips, and posts the pricings from the former to the latter. Thus two complete sets of inventory slips are obtained. These are arranged numerically in blocks of five hundred and turned over to independent groups of calculating machine operators to extend. Subsequently, clerks with adding machines find the totals. The two sets are next proved against each other and must agree absolutely. If any discrepancies appear, the figures are gone over until the errors are found.

The triplicate tag, which is a manila card, remains on the article until the person responsible for the inventory in each department has passed through and satisfied himself that every item of stock has been tagged. But this final tag is not removed until all numbers have been accounted for.

For record purposes the yellow slips are transcribed on larger sheets of paper. These are checked carefully against the originals, but they are extended and totaled separately in the same blocks of five hundred numbers. The accuracy of the copying thus is attested and a third check furnished on the mathematical work.

In case of goods in process, a tough manila tag, instead of the weaker triplicate tag, is employed (Form LVI). The tagging begins the day before the inventory. The next day in listing this stock, the part symbol, order or (motor) car number, quantity, description and last operation performed on the stock are indicated. If the stock is damaged or imperfect, its condition is also noted.

After the tags have been inspected by the head, they are removed and returned to the office. Here they are checked against the manufacturing orders issued and in process, then priced, extended, totaled and transcribed on the large second sheets, as are the stock slips.

These sheets are finally bound in leather covers and kept handy for the manager. For several months afterwards he finds in the facts recorded a potent leverage on the production department

to reduce any surplus not merely of standard parts, but especially of stock on old models.

Only goods in process are actually counted under this routine. A perpetual inventory is maintained on all material in the stock-rooms, both by bin tags and by an office record. These are compared frequently, and any discrepancies are at once reconciled. Whenever an article reaches its low limit, the storekeeper makes an actual count and reports his finding to the office. Any adjustments in the records are made then and there. Thus, in fact, the physical inventory of material in the stock-rooms is in progress daily throughout the year.

So accurate have the records been found that the supervising auditor of inventory is willing to accept their witness as sufficient.

At the Elgin Watch Company, where a similar inventory plan is followed, out of fifty bin tags selected at random not one was off on the tally. Considering the small bulk of many parts handled, this was a remarkable showing. The auditor's representative, after making this test, turned and said: "We don't need to go any further. I'm willing to take your paper record for this part of the inventory."

To have gone into an actual physical count of the millions of small parts in stock alone would, in this case, have required many days. Reliable perpetual inventory records of material in store-rooms, however, leave it necessary only for the stock on the floor to be counted. Consequently the time out for actual inventorying is reduced to a minimum.

It is possible even to dispense with the yearly physical inventory of goods in process by operating proper running records of production. Bulk materials as flour, pig iron, cement, coal, wood alcohol, paint, varnish, and oil, readily lend themselves to such accounting, as they permit of a daily labor and material cost. So also do single piece products where the operations are few and clearly distinguished. Assembled products involving many small parts, like automobiles, typewriters, clocks and watches, are not so easily handled, as the clerical work of operating the perpetual inventories covering the work in all its stages would be enormous and the chances for inaccuracies are great. Indeed, it is a question whether the cost of the clerical work

would not exceed the gain, especially when by keeping an accurate perpetual inventory on stocked parts and by making proper preparations for the goods-in-process inventory, the latter operations can be reduced to a single day, as at the Chalmers plant.

MAKING EACH FOREMAN RESPONSIBLE FOR THE CONTENTS OF HIS SHOP

A PLACE for everything and everything in its place simplifies inventory. This is the basis of the procedure at the Lidgerwood Manufacturing Company's plant. Each foreman is responsible for the inventory of the contents of his shop, including tools, fixtures, and appliances of all kinds, as well as finished and unfinished work.

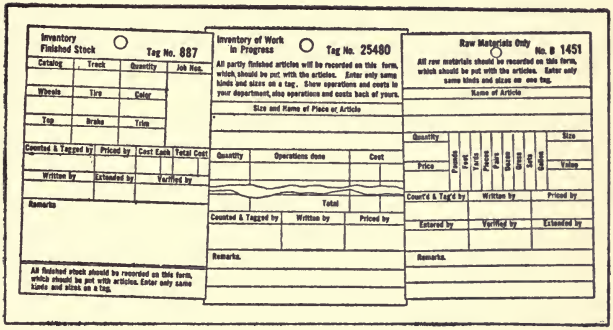
Small blank books with ruled lines are prepared. Each book has a number and contains the name of the foreman, the date of the inventory and a few explicit instructions as to exactly what detail is to go into that particular book. These instructions are typewritten on colored paper and pasted on the outside of the book.

The foreman selects competent men and assigns them to definite things. For instance, one man goes through the work-bench drawers and inventories their contents—hammers, chisels, files, bench brushes, and so on—which are the company's property. One or more men are assigned to inventorying all the rough castings, another inventories all of the partly finished work, and another the finished work.

These books are written up by some one under that particular foreman and come in to the superintendent. The superintendent looks them over and portions them out to different clerks who in turn copy the items with their respective values in other books which go to the New York office.

Perpetual inventories are used for keeping track of machine tools, jigs, fixtures and the like, so that the books simply carry the numbers of discarded tools or additional tools. Jigs and fixtures are all made to a certain series of order numbers so that the exact cost of each item as made may be had. A permanent inventory of the various systems of piping and wiring is also kept and the changes each year are simply noted as additions or subtractions.

At the Studebaker Manufacturing Company's plant cards (Forms LVII-LIX) have been especially devised as the most satisfactory way to take the inventory. These cards are arranged (says the purchasing agent) so that we make our inventory in duplicate by the use of carbon-backed paper. Both the



FORMS LVII–LIX: These forms are made out in duplicate, and are used for classifying and checking raw material, finished stock and goods in process. By making the records in duplicate, one copy can be used for pricing, while the other is used in summarizing total quantities

original and duplicate are numbered the same. The duplicate enables us to forward two divisions of our work at the same time. One copy is sorted as to quantity and size while the other copy goes to the purchasing department to be priced.

Before starting an inventory we take our factory insurance maps and lay out the territory to be inventoried along insurance lines. Each building and each floor in each building is a separate division and is inventoried according to its building and floor number. In this same manner we lay off the courts between the buildings and our lumber yards, and the person who will be responsible for inventorying each division is notified in writing and is supplied with the necessary cards.

Everything in the inventory division is counted twice and then checked by the person who is responsible for the inventory in the division. The first counter takes the inventory card and counting the material or weighing it as the case may be, marks the inventory card and leaves it with the material. The second

counter follows him as closely as possible, counts the work a second time and marks his result on the ticket and turns it over to the man who does the checking. If there is any difference between the two counts the checker should catch it. If he does not, another count is called for when the cards are turned into the office.

This company keeps a perpetual inventory of all of the plant equipment accounts as well as the finished stock and the storeroom accounts. Whenever the stocks run low in any one of these items, the balance on hand is inventoried and proved with the records. It is sometimes necessary to make adjustments due to clerical errors, but as a whole the plan has proved feasible and satisfactory.

Two methods of keeping a perpetual inventory are in general use. One provides for the posting of receipts and disbursement orders on the respective stock cards by men who have no other duty than carrying out the balance; the other for the recording of receipts and disbursements on "in" and "out" cards tacked to each bin or lot of stock. The former is preferable chiefly because errors are less likely to occur when the task of posting the movements of stock and supplies is specialized. The stockman, both a clerk and a laborer under the "in" and "out" card system, often neglects the posting, especially when confronted with many in-shipments and disbursements. Moreover, this method presents complications in that it is not always possible to cover all the supplies and materials of one kind by a single tag. Many plants, on the other hand, operate both kinds, deeming the office record indispensable and the bin tags of sufficient value in addition to warrant the duplicated clerical work. The fact, too, that an independent record is maintained in the office serves to make the storekeeper more attentive to his tags.

A properly kept perpetual inventory record makes unnecessary the taking of stock in the ordinary way. But it is well to check up by an actual inventory until you are satisfied that the perpetual record is dependable. Even then it is on the side of safety to make a complete physical count of some section of the stock-room every two or three years, and every year to check up a few bins or shelves here and there. The fact that you will do this has a wholesome moral effect on both the storekeeper and the record clerk.

Viewed correctly, a perpetual inventory is after all only a device for spreading the physical count over the entire year on as much of the material as practicable. This permits the job to be specialized, which promotes efficiency and makes it unnecessary to break in on the time of the shop. Virtually all plants that operate such records have a more or less systematic plan of checking. Some have the storekeeper make a physical count whenever an item reaches its minimum. Others, notably the Jos. T. Ryerson & Son Company have a man from the office go through a definite list of items each day, so scheduled that the entire stock will be covered by inventory time. A large New York electrical company has gone even further. All its storeroom material is divided into classes. Thus, mining and underground supplies are classes one to ten; and arc lamp parts, incandescent lamp and light hardware are classes eleven to twenty-five. Definite dates are then set upon which material in certain classes will be checked. For instance, on February 28th material in classes one to twenty is taken; on April 30th, in classes twenty-one to twenty-nine; and on May 31st, classes twenty-two to twenty-five. Thus by the end of the year, every class of material will have been counted and checked against the stock ledger balances.

Inventory, it should never be forgotten, offers opportunities to reduce stock in excess of that actually required for the most efficient and economical conduct of business. The inventory, however, must be thorough. It will show the approximate age of each item and the consumption during, say, the past year, or running farther back if available, as well as the amount and value on hand. Even with as thorough an inventory as it was possible to obtain through the departments ordinarily attending to such matters, one concern found that a great many items were either omitted, or so inaccurately described, that it was necessary to go through the factory and storerooms to complete the records for this work.

As the plan worked out in this factory such stock was then listed according to types and sizes of apparatus—in fact, no stock was disposed of without first determining the use for which it was intended. This rule was found wise, for parts and raw material readily lose their identity as they become obsolete or

inactive, and because of changes in description and in methods of stockkeeping. Attention was then directed to the disposition, as economically as possible, of the large overstock. At the same time, however, careful study was made as to the causes producing such overstock so that arguments for preventing future accumulations so far as practicable might thereafter govern.

It might be supposed that by setting proper high and low limits any large surplus would be rendered unlikely. Such is the case with factories like the Ford plant, which operate continuously on one product. Also by guarding against important changes in the design from year to year, any large stock of obsolescent parts is avoided. Ford's policy, therefore, has saved him thousands of dollars on his inventory. With the same end in view, the H. H. Franklin Manufacturing Company adhere rigorously to the schedule laid out at the beginning of the year, and if the engineering department makes any changes in mid-season, the loss involved is charged against that department.

In the average factory making to stock, however, the schedule must be continually readjusted to suit the shifting currents of demand, and the high and low limits set today may have to be altered radically tomorrow. Hence, the management cannot exercise the same close control over the quantities of stock on hand and must depend more or less on the discretion of the production clerks. At the Detroit Lubricator Company's plant the clerks are graded on their ability to keep down an overstock and avoid getting caught with a large supply of obsolete parts on hand. Failure to sustain a creditable showing is penalized by loss of position. At the Northway Motors and Manufacturing Company, the clerks in charge of the production of stock parts are paid a bonus in addition to their salaries for improving on the previous year's showing at inventory time. Their wits are thus sharpened throughout the year to avoid any over-production and the result has been an increasingly tight inventory, netting the company a large financial saving.

Inventory valuations present a problem which has been met in various ways. To get back to the correct principle it is advisable to note that manufacturers secure profits or incur losses from two sources—manufacturing and speculative.

Manufacturing profit or loss is taken only after all of a series

of transactions have been completed; after raw material has been, by the expenditure of labor, transformed into finished product and that product has been sold. In businesses where the market value of material fluctuates greatly, however, the speculative loss becomes a matter of importance; and once or twice a year should be taken into consideration in the general books as an element distinct from, and in addition to, manufacturing profit or loss.

Speculative profits almost invariably should be ignored. Certain decisions which have been handed down in the courts make it a very questionable proceeding for a manufacturing concern to declare dividends between the cost and market value.

Inventories may be taken then: first, at cost; second, at cost or market, whichever is lower.

It will be seen that, if inventories are taken at cost, speculative and manufacturing profits or losses become one. In other words, the market value of raw materials is presumed to affect the affairs of the concern only by whatever influence such values have upon the selling price of the finished goods.

If inventories are valued at cost or market, whichever is lower, the effect is to ignore speculative profit (permitting it to be expressed in extra margins when the goods are sold) and at the same time to recognize speculative loss in an immediate way.

Many bookkeeping authorities hold that the second method is the proper one, and indeed it is, provided that what is required is merely to determine the financial status of a concern at a given time. When, however, the cost finding and bookkeeping records are checked against each other by means of controlling accounts covering the value of materials on hand, goods in process, finished goods on hand, and so on, this second method would involve the necessity in the cost department of re-pricing materials, re-calculating the cost to date on unfinished orders and readjusting the value of finished goods on hand. This in many instances would be not only undesirable but clerically next to impossible.

Inventories, therefore, should be taken primarily at cost and should be carried in the controlling accounts at all times at cost. In case of a falling market, inventories also should be taken at the market and an account should be opened in the ledger covering this depreciation. This account may be called

inventory-depreciation reserve, or any other appropriate name.

In most instances, when controlling accounts are opened, monthly closings are made. Usually, however, it would be found a matter of some difficulty to determine what proportion of the depreciation reserve could be thrown against the profit or loss monthly. It would ordinarily be advisable, therefore, to permit this account to stand on the ledger until physical inventories again were taken. Adjustments will then be made in view of market conditions at that time. Out of the physical inventory, as this discussion suggests, may come not only improvements in storekeeping methods, but also the correction of buying policies. No concern is in a position to ignore such lessons. Large speculative losses will be interpreted into overbuying, overcaution against shortage, and unsound judgment as to the trend of prices. If slightly different varieties of a material or supply are listed on the inventory sheet, the call to standardize is plain. If the figures for obsolete stores are mounting, the sagacious manager will organize a committee to keep in touch with the new things, as well as have shop and sales department get together on a permanent plan to clear away obsolescent items before they become relics.

The purchasing agent is the differential between the almost unlimited field of supply and the factory's demand for materials, supplies, equipment and new construction. Neither demand nor supply is ever still, and the purchasing agent's plans, consequently, are always subject to readjustment. It is his business to improve upon himself. The physical inventory, the opinion of a foreman who is watching the behavior of a new material, and the report of an association which has made a study of concrete mixtures or steels or enamels, all help him to match his purchases more perfectly with the factory's needs.

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